THE

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THE PACIFIC CABLE.

IT is satisfactory to record that at the recent annual meeting of the Postmasters-General of Australasia, some definite conclusions were arrived at towards the construction of the English cable across the Pacific. At the Ottawa conference the Colonial representatives were by no means unanimous in their opinions as to who should own and work the cable, or, indeed, as to what particular route it should be laid over, and although tenders were invited for its construction and maintenance under various conditions, this action was never regarded by those in the know as indicating that there was any likelihood of the work being carried out until a great many preliminaries had been satisfactorily settled. When referring to an excellent leader which appeared in the *Morning Post* some time ago on the matter, we expressed the opinion that it was about time someone with business capacities took the matter in hand. Mr. Chamberlain has come forward as the man for this. He seems to have told the Agents-General plainly, that unless the Colonies could agree among themselves as to the amount of subsidies to be subscribed by each, and as to the landing places for the cable, it was not much use approaching the Imperial Government any further. The result of this is that the approximate route for the cable is now practically decided, and it is resolved that the cables shall be owned and worked by Government. This resolve naturally followed from the fact that no contractor has ever offered to make and lay the cables on any other terms than a cash payment; but apart from this, it is a very wise precaution, and will effectually check the Eastern Telegraph Company's usual tactics of buying cables which they have been unable to prevent being laid—for instance, the West Coast of Africa.

As soon as the Colonies have further decided on the amounts of the subsidies to be provided by each of them, and have ascertained that the Imperial Government are willing to contribute the sum expected of them, it is to be hoped that those in charge of the undertaking will proceed to obtain advice from engineers who have made the subject their particular study. We want to see this Pacific cable turn out a permanent commercial success, and to ensure this, it should be managed in a business like way, and on account of its magnitude, with more than usual caution. The best of independent advice should be taken, and it should be remembered that if this is to be obtained, it must be paid for. Up to the present the cart has been before the horse. We have had statesmen discussing important technical matters, which the engineer would feel himself incompetent to deal with without a great deal more information than is at present to hand. This sort of thing must mean an additional expenditure of money, and possibly a great deal of trouble in the future. Let the Colonies settle satisfactorily all financial matters, and then proceed, under

the advice and supervision of experts, to properly survey the proposed landings, and the inclines out from them to the deep water of the Pacific. It is these inclines which are far more likely to cause trouble than the great depths, and it is here that careful study should be made by means of surveys, and every care and precaution taken during the laying of the cables. Until these surveys are properly carried out, and not till then, as we have many times before stated, can the types of cable be properly decided on, and satisfactory tenders obtained from contractors. Then, again, it is to be hoped that tenders will be asked for section by section, and not for the whole length from one contractor. necessarily. There is nothing like competition.. The announcement that Sir Saul Samuel and Mr. Duncan Gillies have been appointed to represent the Australian Colonies at the forthcoming Imperial Conference will be received with general approval.

DR HOPKINSON'S INAUGURAL ADDRESS.

THE gist of Dr. Hopkinson's Inaugural Address before the Institution of Electrical Engineers is well summed up in the concluding paragraph :—"My aim," says the doctor, "has been rather to excite in your minds discontent with the way in which the science of electricity is usually arranged, in the hope that such discontent may take an articulate form, and become a demand for something more convenient for your particular purpose." Whether this aim is really a desirable one is, we think, open to question; it almost assumes an existing finality in the knowledge of electrical science, for the possibility of future developments and discoveries which may again upset the rearranged order of things, does not seem to be contemplated. Dr. Hopkinson argues, doubtless, on strictly correct lines, and his arguments may be, as arguments, unanswerable; but whether the following out of his suggestions would result in the very material gain which he evidently anticipates is not absolutely certain. That the rational sequence of the scientific facts is, first, "current electricity," and then "electrostatics," may be admitted, and that the present sequence is the reverse simply in consequence of the historical order in which the discoveries of electrical phenomena were made, may also be admitted, but it is exceedingly difficult, even on Dr. Hopkinson's showing, to fully appreciate the value of his logic. The Address, in the main, reveals no novelties; it really consists of a well arranged series of elementary electrical facts which are known to most amateurs, the order in which these facts are arranged being, speaking generally, the reverse of that usually adopted. Dr. Hopkinson states that by following out his method the Maxwell theory of electro-magnetism, about which there has been considerable contention, falls so naturally into its place, that its assumption would be almost unnoticed; and, moreover, the theories of light with that of magnetism are brought into line, and the hypothesis of two electric fluids and the ethereal theory of light become unnecessary; indeed, Dr. Hopkinson considers that their existence has delayed rather than retarded the acceptance of a great generalisation.

Dr. Hopkinson's views appear to be chiefly put forward with the view of helping practical men, and they are probably rather a consequence of this than of strict scientific logic. In other words the doctor practically says, "What use has all the information been to you about static electricity; you would have been much better off if you had only troubled yourself about current electricity"; this is hardly a satisfactory conclusion from an educational point of view. There are many things we have learnt, the direct value of which we cannot trace, but which as exercises of the mind have been most valuable, and which could not have been left unlearnt without detriment to our reasoning powers. There is another point which seems to have been overlooked, and that is that the logical sequence of scientific facts cannot always be followed for financial reasons. Give a boy a book on electricity arranged according to Dr. Hopkinson's ideas, and he will probably be unable to follow it page by page, as the apparatus required for even the simplest experiments on current electricity would be beyond his means, whereas experiments on electrostatics can be very largely carried out with such materials, from the stick of sealing wax to the domestic cat, as every household possesses, and these experiments, carried out doubtless in a way at which the straight-laced scientific professor would shudder at, are most valuable. The child learns to walk by continually falling, and to know by groping about in an aimless way at first, and for this kind of education there cannot be substituted one more strictly logical.

When is it Advantageous to Use Water Power and Electrical Transmission?

DR. EMERY is a steam engineer, and when he admits the economy of water power we may safely allow it. He sees the disadvantages incidental to the utilisation of water power with a keen eye, and so will every engineer who has experience in arranging for a system of water power and has required to face also the provision of a boiler for warming purposes. The absolute necessity of a boiler is all to the disadvantage of any utilisation of water power for power purposes, but Dr. Emery, in his article in *Cassier's Magazine*, under the above head, makes a point of the fact that a water power may be used for lighting purposes where it would not pay for power purposes. He does not lay the cause to the debit of the heating requirements of a factory so much as to the fact that lighting is so much easier than power transmission, so much more direct than the cost of motor transformers in a power system, and of extra attendance and losses in transformation, all are to be set against this. Investigating the question of cost Dr. Emery adheres to the figure of 12s. per ton for coal, which is generally to be taken as the cheapest figure with which water power can compete, so great are the incidental expenses in utilising a fall. This assumes a 10 hours day. Beyond 10 hours steam continues to cost just as much per hour, or nearly so, whereas water costs no more for 24 hours than for 10 hours, and for long days water power becomes able to compete with even cheap coal. As the number of water powers utilised increases, the experience gained will be valuable, and will bring about reduction in cost of future work, and aid to increase the number of future schemes. Dr. Emery would not discourage water power utilisation, but would emphasise the necessity of taking facts into consideration, and of considering every case on its own merits. He thinks by preventing the waste of experiments which are really hopeless and cannot be other than financial failures, to further the really practicable undertakings.

PHOTOGRAPHING THE UNSEEN; OR, THE NEW ELECTRO-PHOTOGRAPHY.

Prof. Röntgen, of Würzburg University, has just made what promises to be an epoch-making scientific discovery. As announced in several of the morning papers of January 6th, Prof. Röntgen has discovered a new kind of light—or, at least, radiation—which penetrates wood and the flesh of men and animals, without, however, penetrating bones and most metals. The professor has succeeded in photographing metal weights placed in a shut-up metal box, without showing any more impression of the case than an ordinary photographic print shows of the glass of the negative from which it is taken.

As far as we can learn from the imperfect accounts in the daily papers, Prof. Röntgen's results were obtained by the light—or, at least, the radiation in some form—given out from a Crookes's vacuum tube when excited by an induction apparatus. Besides photographing hidden metals, he has succeeded in obtaining photographic prints which show the outlines of the bones of the hand. The importance of the last discovery to medical science cannot be over-estimated. The fact that metals, as a rule, are opaque to the new radiation will make the discovery of especial value for the detection of bullets in the wounded.

These remarkable experiments of Prof. Röntgen have already been successfully repeated by several physicists, and, notably, in this country by Mr. A. A. C. Swinton, whom we have to thank for the following interesting details, and the remarkable photograph of the skeleton of the hand and that of the horn-handled razor, in its case of cloth covered cardboard, which we reproduce. The hand and razor were both photographed through a piece of black vulcanised fibre ·0212 inch thick.

Photo of Hand.

It may be as well to explain that the photographs obtained by Röntgen's method are produced without the assistance of a lens. They are somewhat of the nature of shadow photographs. It may appear to be a solecism to apply the term photography to this process, since light, in the ordinary sense, has evidently nothing to do with it, but the term photography has long been taken to include the action of rays of light beyond the visible spectrum, so that there can be no great harm in extending the meaning to include the new effects discovered by Prof. Röntgen.

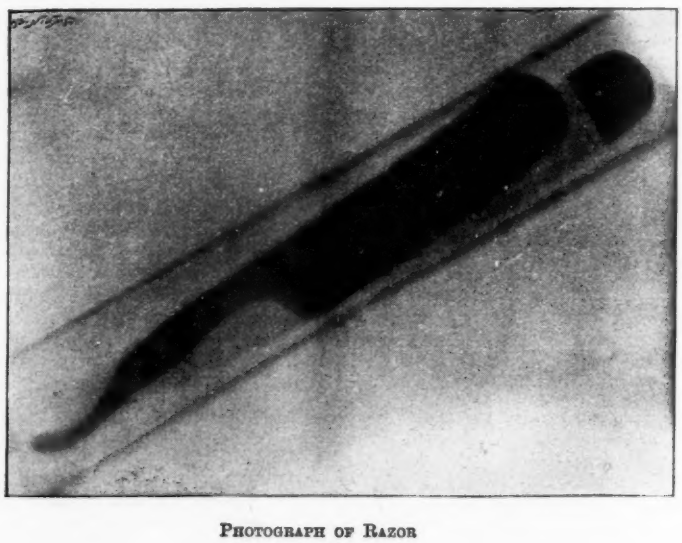
The lamp used by Mr. Swinton is a vacuum bulb with two platinum wire terminals penetrating through the glass, not at opposite points of the bulb, but at two points 90° apart. As, however, this bulb was not specially prepared for this experiment, there may, or may not be, any significance in these details. The bulb also contains phosphorescent material, but Mr. Swinton considers that that has no influence on the result. The terminals of the lamp are connected to Mr. Swinton's well-known induction apparatus for producing rapid electric waves of high tension, such as have been produced by Tesla. Mr. Swinton has also tried a large induction coil to excite his lamp, but obtained no photographic effect with the same length of exposure, so there can be no doubt the rapidly alternating high tension currents are better adapted for producing the Röntgen effect.

The lamp is fixed on a convenient stand about a foot above the table, upon which a dark slide, containing an ordinary photographic plate, is laid. Before the sensitive plate is inserted into the dark slide in the dark room, a sheet of aluminium about $\frac{1}{100}$th of an inch thick is placed against the back of the shutter of the dark slide, so as to exclude the ordinary light when the shutter of the dark slide is drawn. The reason for this is, that Mr. Swinton has discovered that the Röntgen rays penetrate thin aluminium better than the thin wood which forms the shutter. The arrangement, then, amounts to this, that the sensitive surface of the photographic plate is first covered with a thin sheet of aluminium to protect it from light, then upon this sheet of aluminium the object to be photographed is placed and exposed to the radiation from the lamp for about 20 minutes. If the object placed on the aluminium plate is the hand, the result obtained is shown in our illustration. It will be seen that the outlines of the bones of the fingers are sharply defined, and varying thickness of the bones at different parts appears also to a certain extent to be shown by their varying opacity. The outline of the flesh is also shown, but since the flesh is not so opaque as the bones to Röntgen rays, it is easy to distinguish the one from the other. No doubt much better results will be obtained when experiment has shown the best appliances to use.

Mr. Swinton showed us several other interesting photographs which he had obtained by the new process. A purse containing two or three coins was represented in the photograph by the metallic clasp, while the unseen coins came out distinctly as dark circles. Mr. Swinton finds that vulca-

nised fibre is one of the most transparent substances for the Röntgen rays; vulcanite and wood are also transparent, but glass, strange to say, is not so transparent as thin sheet aluminium. Though the metals generally are opaque, aluminium, as we have said, is an exception, and even copper foil shows a certain amount of transparency.

It is impossible to say, with the information at present available, to what these remarkable results obtained by Prof. Röntgen are due. Lenard's* experiments, in which he showed that the cathode rays can pass through a thin plate of aluminium, and produce an impression on a photographic plate, would seem to indicate that Röntgen's results may be due to cathode rays escaping to some extent at least from the vacuum tube; and Lenard's recent paper (p. 99), on the absorption of cathode rays, will be read with interest in connection with the subject. If Crookes's theory that the cathode rays consist of radiant matter be accepted, of course, to explain the remarkable penetrating power of the new rays by referring to cathode rays, would be out of the question. But Lenard's theory that the cathode rays are waves in the ether when dissociated from matter, seems to agree much better with experimental results, and appears to fulfil many of the conditions required to explain the extraordinary discovery of Prof. Röntgen. Full particulars as to Prof. Röntgen's experiments, and his own views on the question, will be awaited with greatest interest. Meantime, from the results obtained by Mr. Swinton, we do not hesitate to say that important results, both to the theory and in the applications of electricity, will follow from this remarkable discovery.



Photograph of Razor

We understand that lantern slides of the hand, and other photographs done by Mr. Swinton, can be obtained from Messrs. Newton, of 3, Fleet Street, Temple Bar, London.

THE USES AND ABUSES OF MECHANICAL STOKING.

The introduction of steam power, now about 100 years ago, gave rise to the familiar sign, less noticeable now than it was 20 or 30 years ago, of "printers by steam power," the word "printers" being replaced by that of any other occupation. To use steam power became looked upon as a sort of password to respect—an assurance of capacity to perform work. Generally the use of machinery became fashionable, and there is little doubt but that in numerous cases machinery was employed to do work that could be done better and more cheaply by hand, and this has been the case more especially in those cases where there has been least labour to displace. Take the case of a small factory where one man easily fires the boiler, runs the engine, oils the shafting, and has still ample time to polish up his bright work to mirror-like brightness. Take such a case, and substitute an ordinary mechanical stoker without any coal conveyer, and requiring the coal to be lifted to a hopper 6 or 7 feet high. Where does this machine save labour? For a skilful use of the shovel has been substituted the less skilful use in throwing coal to double the height. Is the substitution to the benefit of the man? We think not. He now does double the footpoundage of work in lifting coal. He can most easily fill the hopper by over-shouldering his shovel, and at the close of the day he is grimed from head to foot. We think there are few but will agree that the application of a stoking machine to the front of a nicely finished flat ended Lancashire boiler, is not an improvement in the matter of appearance. We have known where even with a single boiler the stoker really has preferred to have the machine, but we can recall only one instance in the shape of a Blackburn weaving shed boiler where this was the case, and in daily life things have to be dealt with as they are found, and it is our opinion that in by far the majority of cases it will be found that the stoking machine without mechanical coal elevator is not a labour saver. Nor is it, indeed, always a fuel saver. Mechanical stoking labours under several disadvantages. We believe that sprinkling machines which keep up a constant feed by means of spring actuated shovels or revolving fans have gone very much out of use. With them the grate was kept uniformly covered with fuel, and in a state of constant flame. The evolution of hydrocarbon gas was continuous, and it was possible to keep to a fairly uniform supply of air, and though the smoke produced during the day was often very large in quantity, it was so evenly spread over all the working time that, though continuous, it never showed very largely at the chimney top, and the smoke inspector could never pluck up heart to say there was black smoke. Where coal was very dusty, the dust was simply winnowed out by the draught, and carried in a more or less carbonised condition right away to the chimney, and this was a serious disadvantage at least in cities, only to be avoided either by damping the coal sufficiently to adhere in such mass as to overcome the carrying power of the draught and deposit the fuel on the fire, or by the application of the "stive room" principle, as in the flour mill, a thing we never heard of being done, but which seems to us likely to be effective with dusty coals. Nevertheless, the sprinkling stoker seems to have been superseded by machines on the coking principle. In these machines the coal is pushed upon the dead plate end of the bars, and is moved forward towards the bridge end by the peculiar movements of the bars themselves. Starting thick, the fire burns thinner as it travels forward, and when the end of the grate is reached, there are apt to be holes in the fire through which an excess of air can pass causing reduction of temperature and efficiency. This fault is overcome, to some extent, by keeping the bars short and rejecting the fuel, still not completely consumed, over their forward ends into the flue beyond the bridge, which is, in fact, kept down to grate level. Combustion of the residue of unburned fuel takes place in a mass in the flue tube, and as the heap of incombustible residue accumulates it is removed by a rake, the lower part of the bridge also being absent, and the mass of mixed ash and half burned fuel alone blocking the passage of air direct to the flue, while allowing enough air to pass to burn off the combustible remaining. Under suitable conditions this arrangement serves fairly well, and it is open to us to block the ash-pit, or part of the tube below the grate at any point we like in the length of the grate by a close fitting movable plate, or otherwise, to so arrange the grate bars that the air space through them is reduced to a minimum where the fire is thin, in order to counteract the effect of too thin fires. It is therefore clear, when these various points are considered,

* Electrical Review, November 2nd, 1894.

that there is a good deal to be said in favour of hand firing. The disadvantages of hand firing are that small coals, which can be used by mechanical stokers, can only be hand fired in small quantities at a time, and this involves the enormous losses inseparable from frequent opening of the fire door, the absence of which loss must serve to counter-balance many of the disadvantages of mechanical firing, and, moreover, must add to the durability of the boiler by reducing such stresses as arise from temperature variations. The first cost of a mechanical stoker is considerable, amounting to from £70 to £100 per Lancashire boiler, and in small electric plants this adds quite a considerable item to the cost, without any corresponding reduction of labour. In large stations, where every facility is to hand for feeding coal to the hoppers of the machines direct from the coal heap, a saving in labour can be made, and the arrangements for doing this bear a less ratio to the cost of, say, a dozen boilers, than they do to the cost of two or three. A large station, moreover, has better facilities for making coal contracts, and so securing an even grade of fuel for long periods; and in this connection we may say that we have known of a works being stopped simply because the coal for the stoking machines ran short, and the machines could not use the large stuff alone procurable for a few days. Mechanical firing secures economy, because it enables a cheaper grade of fuel to be used than can well be used by hand. Mere dust coal can be used in hand fired boilers. We have seen the dust of Anzin coal—a peculiarly friable French coal—fired by hand in a most satisfactory manner, the stuff being watered on the boiler-house floor until just sufficiently adhesive to be fired in comfort, and prevent the dust being carried by the draught. But to do this it was necessary to use a very moderate draught, and to keep the combustion down to a moderate rate per square foot of grate. Nevertheless the result was good, even though the number of boilers in use was double what would otherwise have been necessary. In a small station, where capital is limited, it may be that the doubling of the number of boilers would be a far more serious matter than doubling the price of coal. The heaviest work in a lighting station is not of long duration, and there is always open to us the choice of two fuels, one a cheap slack to carry the work through the easy hours of the day, and the other a better and larger fuel, broken to uniform size, free from dust, and capable of a high rate of combustion for carrying the load over the peak. Such a double system of working, with the elasticity that hand firing gives to a steam generating plant, would often prove far cheaper in the end than a too rigid adherence to the cheapest fuel and its use by the aid of costly machinery. It has been laid down by men of experience that machine stokers are justified only where there can be employed a man to keep them in thorough repair as well as the stoker to attend to them. It is often claimed that a mechanical stoker cannot be forced beyond a certain rate, and that it must be maintained at a constant *régime*. This is so. Any further duty must be obtained by putting on more boilers for the peaks of the load. It would be more difficult to change the fuel than with hand firing. All these considerations point to the simplification of small stations and the avoidance of extraneous expenditures beyond necessity. The same reasoning applies to some extent to the question of the engine, which may be allowed to run wastefully over a sharp peak in the load curve rather than that it should be inordinately large, and therefore wasteful for the remainder of the day. The one drawback to engines wasteful over the peak is that they make heavy demands on the boilers when these are already pretty fully taxed. This strengthens the argument in favour of superior fuel for a short interval of time. And again, it by no means follows that, because with suitable conditions economy accompanies the use of steam of high pressure, therefore it is economical to run all day at a high pressure. It is quite an open question whether in every-day practice it would not prove an economy to work at high pressure for the short period of top load, and to run at half or two-thirds the pressure for the rest of the day. Wear and tear of boilers would be reduced by this course, and it would not be difficult to follow out in connection with the use of two qualities of fuel. The economy of high pressure steam is one thing: its attainment in actual practice is quite another thing. Like casting out evil spirits, it is a question of care and fasting, and, in small stations—and we have in our mind the extension of electrical works much further a-field than as yet they have reached, and on a much smaller scale than public stations have hitherto been built—there is every reason to expect that moderate pressures and moderate speeds will be better controlled by the men who will be responsible for their running than could possibly be the highly-pressed machinery of a city station. Electrical engineers seem to have overlooked the little country towns, little larger than villages, where the expense of mains cannot be so much a question of their length and weight per mile. The whole economy of the small station is entirely different from that of large stations, and should be approached differently; and it is quite probable that there will be greater simplicity sought for in the future, when engineers are called on to fill in the smaller details of the electric lighting of the country. We would suggest the wisdom of very careful consideration of the question of mechanical stoking in small stations, for there can be no satisfaction in this unless done thoroughly in conjunction with coal conveyers. Engineers of small stations should pause before loading themselves with too heavy a capital account, and should make sure of their coal resources before investing in machines that, to a certain extent, limit the supply of coal to a narrower field.

THE ABSORPTION OF CATHODE RAYS.*

By P. LENARD.

Since, among the metals, solid bodies which are transparent to the cathode rays were for the first time discovered, proof has been obtained of the transparency of other materials also. It has turned out that not only the metals, but also, probably, all solid bodies are penetrated by these rays, though only when in very thin layers. No single solid body has been found which behaves towards the cathode rays as glass does towards light. The gaseous bodies, on the other hand, have proved much more transparent than the solid bodies; the transparent thicknesses in the case of the former are measured by centimetres; they give, therefore, a readily available relative measure for the transparency. Measurements showed that the transparency of a gas decreased as its density increased. It appeared to me that this relation was capable not only of more accurate determination, but also of being extended beyond the gaseous condition into the region of the very dense, solid bodies. This induced me to investigate quantitatively the transparency of a greater number of gaseous and solid media, and to estimate for each an exactly defined absolute measure, to be called the absorptivity or power of absorption. The results, to be presently given, can be summed up in the proposition: that the ratio between the absorptivity and the density for all media is approximately constant for the same kind of cathode rays—whatever the state of aggregation of the medium may be, and whatever the material may be of which it is composed.

This proposition, however, gives only an approximate expression of the facts, as ascertained up to the present. If, however, the deviations from constancy of this ratio in different media appears in single cases, considerably greater than the probable uncertainty of the experimental method, these deviations are infinitesimal in comparison with the range over which the proposition holds; for instance, the density and absorptivity vary ten-million-fold from the rarest, just perceptibly absorptive air, to the dense, almost opaque solid gold.

The absorptivity for cathode rays appears to be, like inertia and weight, an expression of the mass of the material; the constitution of the matter and its internal arrangement, which has so great an influence in the case of light, comes here into consideration only in the second approximation.

1. If cathode rays proceed out of the window of a discharge tube, such as has been described in a previous contribution,† into the space where observations are to be made, and if this space is filled with an absorbent material, the

* *Wied. Ann.*, V. 56, p. 255.

† P. Lenard, *Wied. Ann.*, 51, p. 227, 1894.

intensity of the radiation will diminish as the distance, r, from the window increases, for two reasons; firstly, because the radiation spreads out on all sides from the point forming the window, and, secondly, on account of the absorption. The first cause will reduce the intensity as $\frac{1}{r^2}$; the simplest assumption, which can be made about the second, is that in equal distances, equal fractions of the intensity will be lost, *i.e.*, the decrease will be as e^{-ar} where a is a constant, characteristic of the medium, which we shall call the absorptivity of the medium for cathode rays. Both causes act simultaneously in our experiments, therefore the intensity, J, of the radiation at a distance, r, from the window will be given by the equation :—

$$J = J_0 \frac{e^{-ar}}{r^2}$$

where J_0 is a constant, which denotes the initial intensity of the radiation.

It is with the assumptions made in this equation that we shall consider our experiments. Experiments to prove these fundamental assumptions, and which confirm them, at least, as a first approximation, will be more closely discussed in the course of this paper.

GASEOUS MEDIA.

2. The absorptivity of atmospheric air, and that of hydrogen gas, I have endeavoured to evaluate at different pressures in the following way. The observation compartment is first filled with the gas to be investigated, and the phosphorescing screen is adjusted at such a distance from the window that it is just perceptibly illuminated by the cathode rays; let this distance from the window be r. Let the observation compartment be now completely pumped out, and the limiting distance of the screen again ascertained; let this be $r_0 > r$. Then the following two equations hold.

For the space filled with gas

$$i = J_0 \frac{e^{-ar}}{r^2}.$$

For the vacuous space

$$i = J_0 \frac{1}{r_0^2},$$

in which i denotes the intensity of the radiation which just perceptibly illuminates the screen. By eliminating the constant $\frac{i}{J_0}$ the absorptivity of the gas comes out

$$a = \frac{2}{r}(\log r_0 - \log r).$$

I have already published* an account of experiments such as are here required, and the results are given in the two first columns of the following tables I. and II. The distance, r_0, corresponding to zero pressure (the last lines of the tables) is made equal to the mean value of four distances, 140, 133, 131, 130 cm., which were measured with pressures varying from 0·019 to 0·0083 mm. in air, and from 0·030 to 0·0164 in hydrogen, which showed no connection with the pressure or the gas.

TABLE I.—ATMOSPHERIC AIR.

Pressure. p.	Length of ray. r.	Absorptivity. a.	Percentage transmitted through 1 cm. $100\,e^{-a}$.	$\frac{a}{p}$
mm.	cm.	cm^{-1}		
760	2·35	3·43	3·2	0·00452
331	4·53	1·55	21·3	0·00467
165	8·38	0·661	51·6	0·00400
83·7	12·1	0·396	67·3	0·00473
40·5	17·1	0·235	78·5	0·00579
19·3	27·2	0·117	89·0	0·00604
10·0	49·5	0·040	96·07	0·00400
2·7	73·0	0·0166	98·35	0·0061
0·78	107	0·00416	99·93	0·0053
0	133·5 = r_0	...	...	...

* P. Lenard, l. c., p. 252.

TABLE II.—HYDROGEN GAS.

Pressure. p.	Length of ray. r.	Absorptivity. a.	Percentage transmitted through 1 cm. $100\,e^{-a}$.	$\frac{a}{p}$
mm.	cm.	cm^{-1}		
760	10·6	0·479	61·9	0·000630
335	21·1	0·175	82·0	0·000522
167	32·4	0·0873	91·64	0·000522
88	38·8	0·0637	93·83	0·000723
42·2	56·1	0·0309	96·96	0·000733
20·3	74·9	0·0154	98·47	0·000757
10·3	96·8	0·00664	99·33	0·000644
3·3	122	0·00149	99·86	0·00045
0	133·5 = r_0			

The calculated absorptivities, a, will be found in the third column of the tables and in the next column, the values of $100\,e^{-a}$ which give the percentage of parallel rays left after passing through 1 cm. thickness of the gas. One can see, for instance, this is not more than 3·2 per cent. in the case of atmospheric air at the ordinary pressure, while at a pressure of one-quarter atmosphere nearly one-half of the rays are transmitted, while hydrogen gas even at the normal pressure transmits as much as 62 per cent.

If the ratio between the absorptivity and the pressure is worked out in each case, as shown in the last columns of the tables under $\frac{a}{p}$, it will be found that this is a quantity independent of the pressure of the gas. The deviations are well within the limits of experimental error.

We deduce, therefore, from our experiments the result that the absorptivity of a gas is proportional to its pressure, or, what is the same thing, to its density. Or, in other words, if we enclose a given quantity of gas in a cylinder with a piston, the transparency of the column of gas along its axis is always the same, however the gas may be compressed or rarefied by the movement of the piston. The same mass of gas absorbs at all pressures the same quantity of cathode rays.

3. Principally with the view of establishing the fundamental principle (1), I have endeavoured to determine the absorptivity of atmospheric air at normal pressure in another way. The principle underlying the method was to reduce the intensity of the cathode radiation to a known amount by placing a screen in front of the window. For instance, if the intensity is reduced to $\frac{1}{n}$, and r and R are the two distances from the window; then by the equation already given, without the screen interposed,

$$i = J_0 \frac{e^{-aR}}{R^2}; \qquad t$$

with the screen interposed,

$$i = \frac{1}{n} J_0 \frac{e^{-ar}}{r^2}; \qquad t_1$$

from which the absorptivity of the air comes out

$$a = \frac{1}{R - r} \log \frac{n r^2}{R^2}.$$

The screen which effected the weakening of the radiation by a known amount, was a metal plate perforated like a sieve. The spreading out of the rays after passing through the perforations made the illumination on the phosphorescent screen practically uniform, so that the screen acted as if it was uniformly transparent to the same extent. Experiment, indeed, showed that it was a matter of indifference at what distance the perforated screen was placed from the window or the phosphorescent screen, provided it was not brought nearer to either than 1 cm. The holes in the screen were made at the intersection of two series of parallel lines drawn on the plate at right angles to each other, by a dividing engine, at a distance of 3·37 mm. apart. The holes were bored, smooth and round, gave on an average of several measurements a diameter of 0·461 mm. From this it follows that $0{\cdot}0148 = \frac{1}{n}$, that being the proportion of the opaque screen which was open. The phosphorescent screen was

covered with a sheet of aluminium foil to exclude the light from the faintly illuminated air; a cross piece of opaque material being pasted on the foil, which produced a shadow and rendered the determination of the critical distance easier.

The experiment was now carried out for three different kinds of cathode rays, as produced at three different pressures in the discharge tube.

For determining the degree of rarefaction, as in former experiments, the length of spark obtained between two brass balls connected to the electrodes was used. The following are the results:—

TABLE III.—ATMOSPHERIC AIR, 760 MM. PRESSURE.

Length of sparks.	Length of rays.		Absorptivity of air.
	Without metal screen. R.	With metal screen. r.	a.
Cm.	Cm.	Cm.	Cm.$^{-1}$.
2·6	3·90	3·00	4·10
2·8	4·27	3·20	3·40
3·0	4·83	3·65	3·10

One can see that the absorption in the air for different kinds of radiation is very different, that is to say, the rays produced at higher pressures—therefore, according to earlier experiments, the more refracted and diffused rays—are the more absorbed. The differences of pressure employed are very small, but the corresponding differences of absorptivity of the air are relatively great. This agrees exactly with the behaviour of the ordinary discharge tube. Cathode rays of a meter in length are developed in it at the lowest pressures, while, at a pressure of $\frac{1}{2}$ mm., they are exhausted by passing through a distance of a few millimetres. The transparence of the air in the discharge tube changes in, by no means, so great a ratio; and the assumption that the rays produced under these different conditions have different intensities is quite as unsatisfactory. A possible explanation is that the rays produced at different pressures are absorbed in different degrees.

If we now wish to compare the present absorptivity of the air with that previously obtained, we must take the second line in Table III., for in all previous experiments the rarefaction of tubes corresponded to a spark length of 2·8 cm. We find the agreement of the two results, 3·40 and 3·43 (Table I.) better than was to be expected, and, therefore, we may take our fundamental assumption (1) as to the falling off of the intensity as established so far.

4. I have compared the absorptivity of a large number of gases at the normal pressure with the now known absorptivity of the atmosphere by finding the limiting position of the phosphorescent screen in the given gas and in air under the same conditions. If, for example, G and L are the limiting distances for the gas and for air, g the absorptivity of the gas, and l that of air, then taking the equation already used,

in the gas $$i = J_o \frac{e^{-gG}}{G^2},$$

in the air $$i = J_o \frac{e^{-lL}}{L^2},$$

therefore, the absorptivity of the gas is

$$g = \frac{2}{G} \log \frac{l}{G} + l\frac{L}{G}.$$

For carrying out the experiments, a glass tube 30 cm. long and 3 cm. in diameter, was fixed on the wall of the window, and perpendicular to it. From this tube the air was displaced by drawing the gas to be examined through for a quarter of an hour. In this tube the phosphorescent screen was adjusted from the outside by means of a magnet.* The limiting position of the screen was first measured five times in the air, then ten times in the gas, after the tube had been completely filled with the gas, and after the gas had been repeatedly again drawn through; finally, after the gas had been driven out of the tube, five measurements were again made in the air. The mean values of these measured distances from the window are given under L and G in the following Table IV. Under g are the absorptivities calculated by the formulæ with distances obtained. The gases are arranged in order of increasing densities, those of nearly equal densities being connected by a bracket.

TABLE IV.—VARIOUS GASES AT ATMOSPHERIC PRESSURE.

Gases.	Density (Mol. wgt.) M.	Length of rays.		Absorptivity. g.	$\frac{g}{M}$	Image of slit.
		in air L	in gas. G.			
		cm.	cm.	cm^{-1}		
Hydrogen, H_2	2·00	4·28	23·80	0·473		
		4·33	24·50	0·463		
		3·75	19·74	0·483		
			Mean	0·473	0·237	
Marsh gas, $C H_4$	15·97	3·90	6·30	1·97	0·124	
Ammonia, $N H_3$	17·01	4·23	5·56	2·51	0·148	
Carbonic oxide, C O ...	27·92	4·24	4·20	3·40	0·122	
Olefiant gas, $C_2 H_4$ ...	27·94	4·52	4·23	3·70	0·132	
Nitrogen, N_2 ...	28·02	5·03	5·40	3·18	0·113	
Air	28·88	..	...	3·42	0·118	
Oxygen, O_2	31·92	4·75	5·15	4·01	0·126	
Sulphuretted hydrogen, $H_2 S$	33·98	3·92	3·27	4·22	0·124	
Carbonic acid, $C O_2$ ...	43·89	5·60	3·95	5·04	0·115	
Nitrous oxide, $N_2 O$ ...	43·98	4·03	3·17	4·49	0·102	
Sulphurous acid, $S O_2$ ...	63·90	4·33	1·93	8·51	0·133	
				Mean	0·133	

(*To be continued.*)

* The apparatus resembles that more exactly described, l. c. p. 249, in plate IV., fig. 8.

ON A NEW FORM OF WATER BATTERY.*

BY LOUIS W. AUSTIN AND CHARLES B. THWING.

THE ordinary old form of water battery, consisting of zinc-copper couples dipping in short test tubes set in paraffin, while perfectly satisfactory in its working, is extremely inconvenient to fill as soon as a large number of cells are used, since each cell must be filled separately, and with great care, lest the insulating medium should be wetted. Some years ago Prof. Rowland proposed a battery, very convenient for many purposes, which consisted of a series of zinc-copper pairs cemented to the lower side of a glass plate, each pair

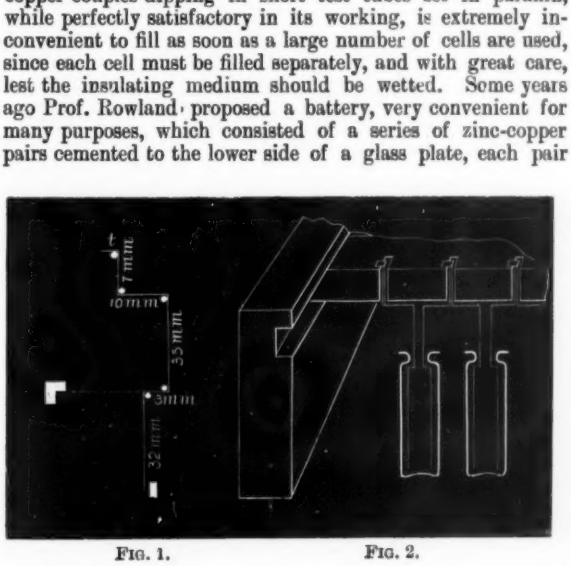


FIG. 1. FIG. 2.

being so near to the next that when the tips of the metal strips have been dipped in water, a drop is held between each strip and the adjacent one of the opposite metal in the next pair by capillary action. This drop will evaporate in about half an hour, when, of course, the battery must be dipped

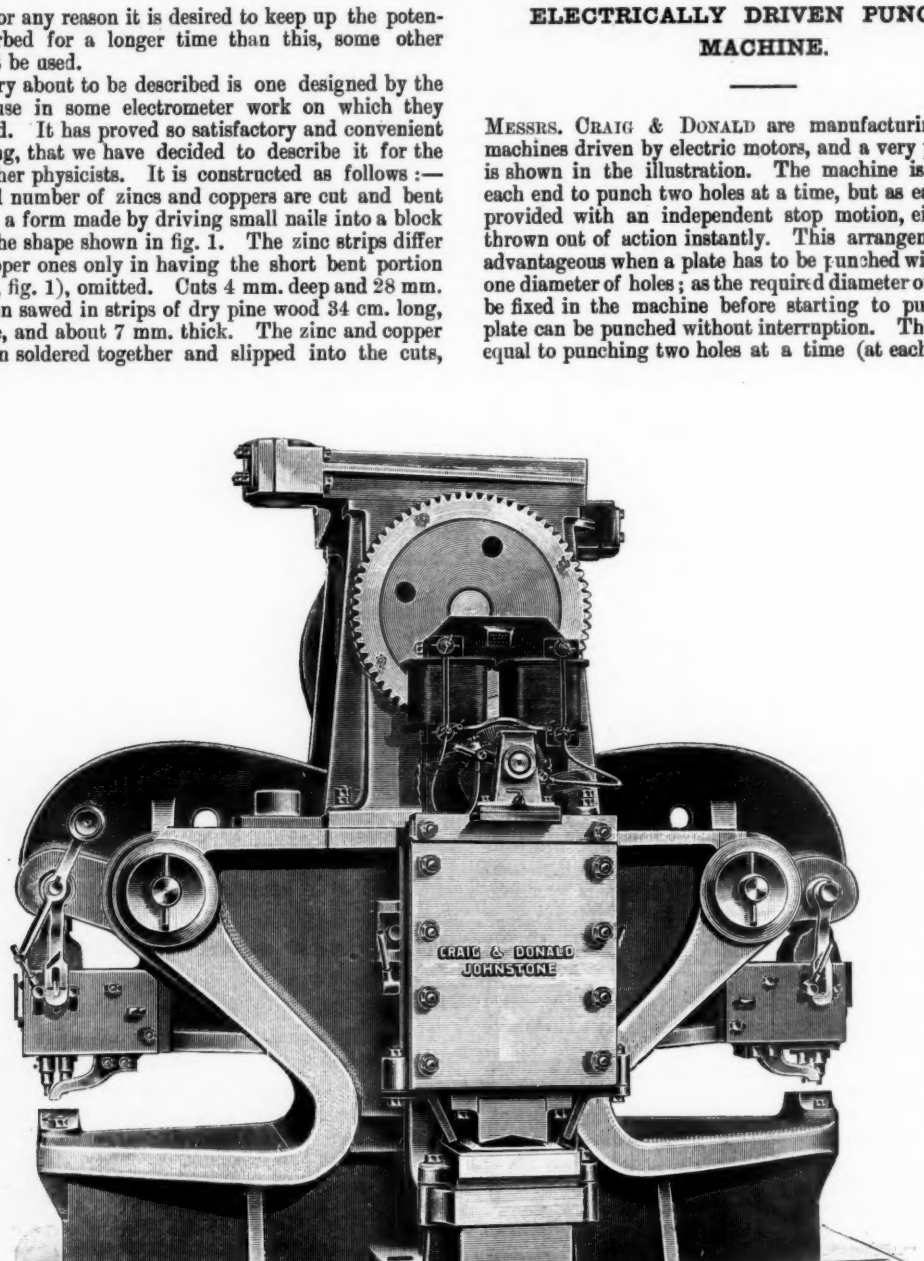
* *Physical Review.*

again. If for any reason it is desired to keep up the potential undisturbed for a longer time than this, some other battery must be used.

The battery about to be described is one designed by the authors for use in some electrometer work on which they were engaged. It has proved so satisfactory and convenient in its working, that we have decided to describe it for the benefit of other physicists. It is constructed as follows :—The required number of zincs and coppers are cut and bent by means of a form made by driving small nails into a block of wood in the shape shown in fig. 1. The zinc strips differ from the copper ones only in having the short bent portion at the top (*t*, fig. 1), omitted. Cuts 4 mm. deep and 28 mm. apart are then sawed in strips of dry pine wood 34 cm. long, 21 mm. wide, and about 7 mm. thick. The zinc and copper pairs are then soldered together and slipped into the cuts, after which 10 strips are mounted together, with the addition of a blank strip to hold the last line of metal pairs in place in the grooved end pieces, and fastened firmly with nails. To secure perfect insulation, the wooden portions are next dipped for a few moments in a pan containing shellac varnish. The battery is completed by springing a 1 drachm homeopathic vial over each pair, the metal strips being so placed that they hold the bottles in position without any other support. The battery is filled by setting it over a pan (30 cm. × 30 cm. and 9 cm. deep), filled with water. The general appearance of one of the frames is shown in fig. 2. In our battery 10 such frames, of 100 cells each, are placed four deep in a portable rack of wood. A battery of this sort, while it can be filled almost as easily as Rowland's, can be used without refilling for several weeks.

ELECTRICALLY DRIVEN PUNCHING MACHINE.

Messrs. Craig & Donald are manufacturing punching machines driven by electric motors, and a very powerful one is shown in the illustration. The machine is arranged at each end to punch two holes at a time, but as each punch is provided with an independent stop motion, either may be thrown out of action instantly. This arrangement is found advantageous when a plate has to be punched with more than one diameter of holes; as the required diameter of punches can be fixed in the machine before starting to punch, and the plate can be punched without interruption. This machine is equal to punching two holes at a time (at each end) 1 inch in diameter through 1 inch thickness of steel, 42 inches from the edge of the plate; or one hole of 1½ inch diameter through 1½ inch thickness of steel. It is arranged with side cutter to cut the notches in stringer plates up to 10 inches by 8 inches through ⅞ths inch thickness.



Electrically-Driven Punching Machine.

The motor driving the machine is of 18 brake horse-power and runs at a speed of 700 revolutions per minute. The camshaft and all gearing are of steel, except the large wheel on the camshaft. The machine has brackets arranged for carrying two cranes.

Messrs. Craig & Donald have just fitted one of these machines into the shipyard of Messrs. William Denny and Brothers, Dumbarton. The machine—engine or belt driven—has been frequently made by them with shears at one end instead of with the double punch.

ELECTRICITY FOR HIGH SPEEDS ON RAILWAYS.

Mr. Hiram Maxim, who writes on the above in *Cassier's Magazine*, starts out from the text that the steam locomotive has reached its maximum speed. He arrives at this conclusion from a comparison of recent English and American high speeds, which differ from one another by a very small fraction, and he shows how, 30 years ago, he might have said 50, practically the same speeds were reached as are reached to-day—evidence he thinks that his contention is true. But he has apparently overlooked the fact that every improvement of the locomotive has been followed, if, indeed, not absolutely preceded by a demand for train accommodation in the shape of dining or sleeping cars, and generally cars of much greater weight. In this connection we might, however, point out that were English locomotives fitted with boilers, and especially fire-boxes as big as those of American locomotives, it would be possible to use cylinders of greater power, or more of them, and so obtain much more powerful engines. Whatever may be the reason of it, it is clear that, from some cause, a greater power is required to haul a given train in America than in England. Still, there is a good deal of apparent basis in the idea that steam locomotives can hardly be made much larger—at least on standard gauge lines. Mr. Maxim admits difficulties in electrical locomotives; for instance, the difficulty of making a motor to work well at very low and very high speeds. This he would overcome by having several motors on one locomotive, arranged to be coupled in series when starting, so as to use high tension current with safety to the armatures. As speed increased, he would change the arrangement, step by step, from series to multiple, until at high speed, all the motors would be in multiple connection, and would develop the highest possible energy. This arrangement, however, was used by Reckenzaun for tramcars years ago.

We observe Mr. Maxim speaks of an electrical locomotive as of a separate vehicle; but would not this same change from series to multiple be equally easy of attainment with so many cars, each carrying its own one or two motors? Any change would be made at one switchboard carried on one vehicle only, and the distribution of the motors along the train would have no effect disadvantageous to any arrangement as suggested.

A great deal is always made of the difficulty of distributing current on a long railway. Mr. Maxim closes with this difficulty boldly. There is, he says, in effect, a boiler and two or more steam cylinders to every train on an ordinary railway. Why then endeavour to crowd the power of scores of locomotives into one central station? He would decentralise to some extent. Why should there be any objection to the use of a large number of steam engines? He would, therefore, dot his generating stations at intervals along the line* and use current of 2,000 to 5,000 volts. The main conductors should be thoroughly insulated and protected from atmospheric influences, while the actual rubbing sections should be relatively short and only connected to the main conductors during the passage of a train, which should switch in the rubbing sections as it passed along and disconnect them behind it, thereby avoiding loss of current and minimising the danger of accident. Economy he would expect to secure by using much less expensive coal than is now used of necessity in locomotives, which demand the best coal to enable them to give a proper duty from their comparatively small boilers. Then, with cheap coal, condensing engines, large boilers with ample grate surface and heating area, he would expect to develop power at a cost 60 per cent. less than is now done in the locomotive, whereas the loss of transmission of current would not exceed 25 per cent., leaving a large margin of saving. In addition to this economy there would be the further economy arising from the abolition of the tender—and, indeed, the locomotive itself, which together may constitute half the weight of a high speed train.

Assuming these arguments to be well founded, the actual cost of propelling a train should be less than 30 per cent. of what it now costs per ton of total weight of train. As to speeds, he would expect to double present speeds, but he would so far consider air resistance as to shape the head and tail of the train to a form of less resistance than the present flat ends, and he would abolish all outside irregularity of surface, which would add largely to skin resistance, and carry the boxing in to the wheels and axles. His own experiments have shown him that atmospheric skin friction is of no serious account when the surface is smooth, but is very serious where surfaces are rough or irregular. The difficulty of sidings, switches, &c., which are so serious a difficulty if the hard and fast advocates of electric traction had their way, he would get over by using steam locomotives, reserving electric traction for the main line alone. He would save what is now lost in braking a train on a gradient by using the descending energy of a train to drive energy back into the line, which would thus be a great economy. He claims that all he has suggested is perfectly practicable and possible with existing available apparatus. Mr. Maxim does not go into the question of cost. He points to the possibility of electrical lines being built very much lighter than steam roads, and claims that heavy works would be avoided, the line following the contour of the country, by which he means, we take it, the surface, not even approximate contour lines, for, with the high speeds he proposes, this latter course would involve too much curvature of the line. A high speed road cannot be safely made to take other than a fairly straight course. But with such a straight course, there is no reason why the sea should not be reached from London in the stated 20 minutes. It is not now a question of mechanical or of electrical possibility.

The financial element is the chief one to be considered, and advocates of such high speed lines must be prepared to show that such a direct line from point to point, which would secure little else than terminal traffic, can be built to pay. We confess we have little faith in the average railway director. He is a small minded creature who grudges the public facilities for cheap travelling, even if he knows that it will pay his shareholders better than existing prohibitive fares, and fares are practically fixed at prohibitive rates. Let us suppose the possibility of a Londoner paying £10 for an annual ticket to the sea. Then each train of 300 seats would earn about two shillings on every mile, for it would run nearly 100 miles a day for £3,000 annually. Its coal bill would be heavy at two pence per mile, leaving 22 pence for interest and wages, &c. With an assurance of the continuance of such a rate the passengers would be forthcoming, but it is hopeless to look for the mass of traffic necessary to steady returns from the classes who can afford to pay present season ticket rates to the sea. There are two things that the mass of the people cannot afford; one is time, the other money, and the sooner promoters realise that people in the mass want to travel rather than to sleep or dine on a train, the better will be their chance of rendering their promotions successful. True, the cost of a train mile on an ordinary railway is somewhere about three shillings. The problem with the high speed electrical line is to secure such full loads as will pay a dividend on a total income less than the prevailing train mile cost of steam roads. We need scarcely point out that the prevailing train mile rate is an average, which includes many costs that would require to be eliminated.

* This suggestion was made in our columns 10 or 12 years ago by a correspondent writing under the *nom de plume* of "Musicus."—Eds. Elec. Rev.

THE BERRENBERG MECHANICAL PUMP.

We have recently had an opportunity of inspecting the Berrenberg-Chaplin vacuum pump, and have had its special properties explained by Mr. Berrenberg, the inventor.

The complete, or perhaps we had better say the adequate exhaustion of an electric incandescent lamp by means of a mechanical pump, has a very important bearing on the cost of manufacture. Lamp makers have sought for a long time to dispense with mercury pumps, but they have generally been so unsuccessful, that we may take it that a fair commercial vacuum by mechanical means has been obtained in only one or two cases. In many factories the rough exhaustion is generally accomplished by mechanical means, but the final vacuum is usually obtained by mercury. It is hardly necessary to point out that exhausting by mercury is one of the most expensive processes connected with the manufacture of incandescent lamps, and the elimination of that method would result in a great cheapening of lamps.

It is claimed that by means of the Berrenberg pump, a general

view of which is shown in fig. 1 and a sectional view in fig. 2, a vacuum equivalent to that existing in ordinary commercial lamps may be obtained in seven minutes, and from our own casual observations an excellent vacuum was obtained in that period. The inventor, however, prefers that the lamps should be exhausted for 20 minutes, and maintains that the results are better than those obtained by mercury.

Before speaking, however, of the method of exhausting the lamps, it will be more convenient to speak of the construction of the pump. The principal feature is the cylinder, in which two pistons are working one inside the other. At the bottom of the cylinder shown in fig. 3 is an air inlet marked A1, which is connected to the lamps by means of pipes. In starting the pump, the two pistons move upwards together, fig. 4; the outer one, however, reaches the top of the cylinder chamber and returns to meet the inner piston, which is continuing its upward journey. When these pistons are together in the position shown in fig. 5, there is a considerable space in the lower part of the cylinder in which air from the lamps collects.

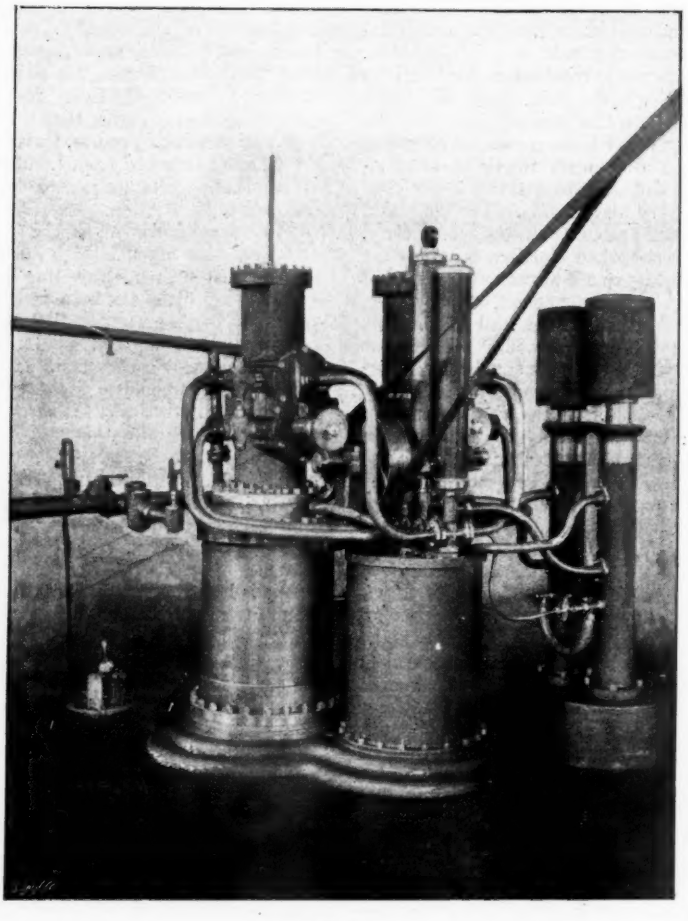


Fig. 1.

As the inner piston descends, this air is forced through valve 1, thence through the oil and into the space 1 between the inner and the outer pistons. When the pistons reach the bottom of the cylinder again, the whole of the air which had collected has been forced into space 1. The motion of the pistons commences again, and as the inner and outer pistons meet each other, the air is forced through valves 2 into the space above the outer piston; then, as the outer pistons move upwards during the cycle, the rarefied air is forced into the chamber marked *ch*, and is then exhausted to the air, or elsewhere, as required. The pump pistons are worked by power pistons, shown in the upper part of figs. 1 and 2. Oil under pressure is pumped into the cylinders, in which are these power pistons, and in order to avoid waste, hydraulic accumulators are provided. A consideration of the drawings will make the working of the pump fairly clear. It ought to be mentioned that the pump pistons are lubricated with a specially prepared oil.

In a mechanical exhaust system, a good deal of its efficiency depends on the freedom from leakage in the pipes connecting the lamps to the pump. Mr. Berrenberg has adopted a method which, for all practical purposes, is air-tight. It consists of a pipe within a pipe, and between these is the specially prepared oil of which we have already spoken. The lamps to be exhausted are connected to branch pipes from the main, by means of special glass stems, which are so beautifully ground that they fit into sockets almost perfectly. Some idea of the branch pipes and the lamp sockets will be seen in figs. 6 and 7.

At Huggin Lane there are two pumps, one of which does the rough exhausting, and the second makes the final vacuum. The first pump is called the auxiliary pump, and consists of four cylinders, which are placed in a tank and surrounded with oil. Air from the exhausted lamps expands into two of these cylinders, and is afterwards discharged into the remaining two.

As this pump has been most exhaustively tested by Prof. Ayrton, it will be of general interest to make an extract from the professor's report, giving the method of testing, and the conclusions :—

"*Method of Testing Pumps.*—For the purpose of my tests, 14 glass bulbs (shaped as in fig. 7) and having a capacity, as measured by me, about equal to that of 15 lamps, and five bulbs having a capacity about equal to that of 11 lamps, were blown on to glass stoppers (s, in fig. 7), and placed in the junction boxes in the branches, 2, 3, 4, 5, and 6, in fig. 5. The total capacity of the bulbs on the pumps was, therefore, about equal to that of 265 lamps.

"For measuring the pressure of the vacua produced by the pumps, I used the McLeod gauge. This gauge consists of a glass bulb terminating in a capillary tube closed to the air at the top, blown on to a glass tube, to the lower end of which a glass vessel containing mercury is attached by a rubber tube. The upper end of the tube is ground into a stopper, which was fixed in the junction box in branch pipe, as in fig. 5. "When it was desired to measure the pressure of the vacuum produced by the pump in the gauge, the vessel was raised, and the mercury rising past the opening, closed the little floating valve, and compressed the air into the capillary tube. The length of the tube occupied by the compressed air, when the mercury was at the same level in the vessel as in the capillary tube, was a measure of the pressure of the vacuum.

"The sensibility of this McLeod gauge was stated by the makers, Messrs. Cetti, to be such, that 1 millimetre remaining in the capillary tube, after the mercury had been raised, indicated that the pressure had been reduced to $\frac{1}{500000}$th of the atmospheric pressure.

"It was, of course, impossible to test the exact accuracy of this figure without entirely dismantling the gauge. I made, however, some rough measurements, which showed that the number was, if anything, too large, rather than too small.

"Hence by using the figure $\frac{1}{500000}$th to determine the pressure of the air remaining in the lamps from my readings of the gauge, the performance of the pump is under rather than over-estimated.

"As explained above, in practice the lamps are partially exhausted by the tank pump *before* they are placed on the system of pipes in connection with the main pump; but as it has not been thought necessary to erect in Huggin Lane a rack on which the partial vacuum could be made, and as the pump does not work to its best advantage when exhaust-

ing from ordinary atmospheric pressure, a pipe was, at my suggestion, brought from the tank pump and connected with a branch pipe through a temporary stop-cock.

"By this means both the partial and the final exhaustion could be done with the bulbs in position, on the system of oil jacketed pipes.

"*Vacua obtained.*—On the afternoon of Friday, December 13th, 1895, the following tests were made:—

"The tank pump was started at 2.48 p.m., and 2½ minutes later the main pump was started.

"At 2.53 p.m., or five minutes from the starting of the tank pump, the cocks *b* and *h* (fig. 7) were opened. After two minutes, a partial vacuum having been produced in the pipes and bulbs, the tank pump was isolated from the system by closing the cocks, *b* and *h*, and the cock, *a*, leading to the main pump was opened. After 15 minutes' pumping, the McLeod gauge read 2 millimetres, showing that the pressure in the bulbs was but $\frac{1}{250000}$th of an atmosphere; after 20 minutes pumping the gauge read 1 millimetre, and, one minute later, under 1 millimetre; proving that the pressure had been reduced to less than $\frac{1}{500000}$th of an atmosphere.

"The stop cock at *a* (fig. 7) was now shut, and that at *b* opened, and air let into the system by taking out one of the stoppers in branch pipe 1.

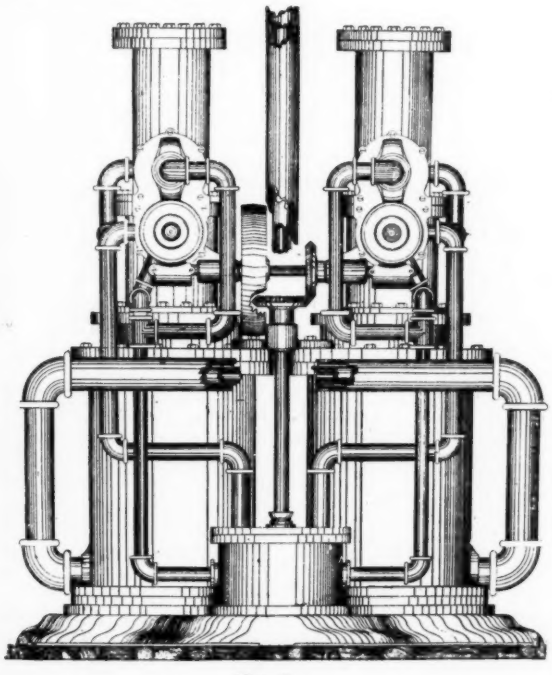


FIG. 2.

"The glass stopper having been replaced, a partial vacuum was produced for 1½ minutes by the tank pump, which was then turned off and the main pump turned on. Readings, the results of which are shown in the following table, were taken with the McLeod gauge at intervals.

Time from turning on the main pump.	Reading of McLeod gauge.	Approximate pressure in atmospheres.
5 minutes	13 millimetres	13/500,000
9½ "	4½ "	1/111,111
14 "	3 "	1/166,666
16½ "	2½ "	1/200,000

"*Comparison with Vacua in Commercial Lamps.*—With the object of comparing the vacua I was obtaining with those found in commercial lamps, a gauge was used in which the vacuum is produced in the lamp bulb, and on lifting the mercury vessel the mercury rises past the opening, and compresses the air in the bulb into a bubble at the top.

"By comparing the size of this bubble with the size of that obtained when an ordinary commercial lamp is broken under mercury, a comparison could be made between the vacuum created by the pump under test, and the vacuum created by the pumps used in the manufacture of the glow lamps examined.

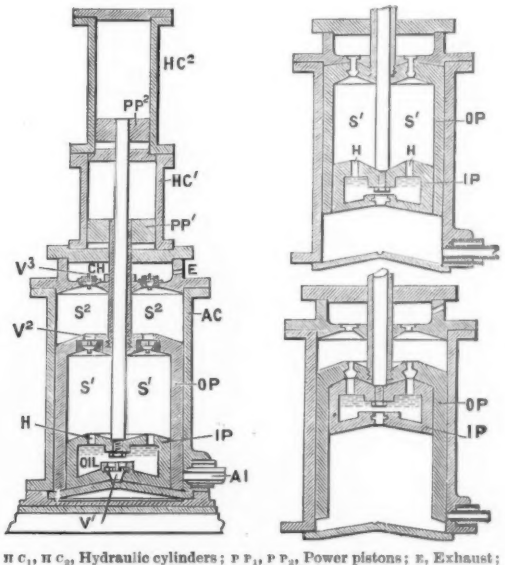
"After putting the new gauge in position, and after producing a partial vacuum with the tank pump, the main pump was turned on, and the following results were obtained:—

Time from starting the main pump.	Reading on McCleod gauge.	Approximate pressure in atmospheres.	Approximate diameter of air bubble in lamp bulb.
2⅔ minutes	5·5 millimetres	1/90,900	0·1 inch
15 "	2 "	1/250,000	0·06 "
21 "	1·5 "	1/333,000	0·03 "

"To obtain the comparison required, I had broken under mercury eight glow lamps of two well-known makes. Of these lamps, one gave a bubble of air of about 0·12 inch in diameter, four gave bubbles having diameters of the order 0·06 inch, and three gave bubbles varying in diameter from 0·25 to 0·5 inch.

"From these results, it will be seen that the pump produced in 21 minutes a better vacuum than that found in any of the eight commercial lamps examined.

"*Facility with which the Glass Joints can be made.*—To test whether or no there was any difficulty in making the glass joints air-tight, my assistant, Mr. Medley, took one of



H C_1, H C_2, Hydraulic cylinders; P P_1, P P_2, Power pistons; E, Exhaust; V_1 V_2 V_3, Valves; H, Holes, A C, Air cylinder; O P, Outer piston; I P, Inner piston; A I, Air inlet; s^1 s^2, Spaces.

FIGS. 3, 4, AND 5.

the bulbs out of its junction box and removed from its connecting tube the glass stop cock (c, in fig. 6). He then re-greased the cock and stopper, and replaced them in their respective positions.

"The tank pump was then used for one minute to create a partial vacuum, after which the main pump was turned on, with the following results:—

Time from starting the main pump.	Reading on McLeod gauge.	Approximate pressure in atmospheres.	Approximate diameter of air bubble in lamp bulb gauge.
5 minutes	14 millimetres	1/35,700	0·18 inch
15 "	5 "	1/100,000	0·08 "
21 "	1·5 "	1/333,000	0·03 "

"From these figures it is clear that no special skill is required in making the glass joints air-tight; a conclusion of some importance, as these joints will have to be made before exhausting each batch of lamps."

Tests were then made of pumping against a leak, which proved that even when working against a leak of some considerable size the main pump was able to create a fairly high

vacuum, and also pointed to the necessity of there being a continuous oil jacket throughout the whole system.

"The air-tightness of the pipes was tested by leaving the pipes from Saturday to Monday, but there was practically little leakage."

Prof. Ayrton concludes:—

"That the combination of pumps as erected at No. 4, Huggin Lane, is capable, in 15 minutes, of creating a

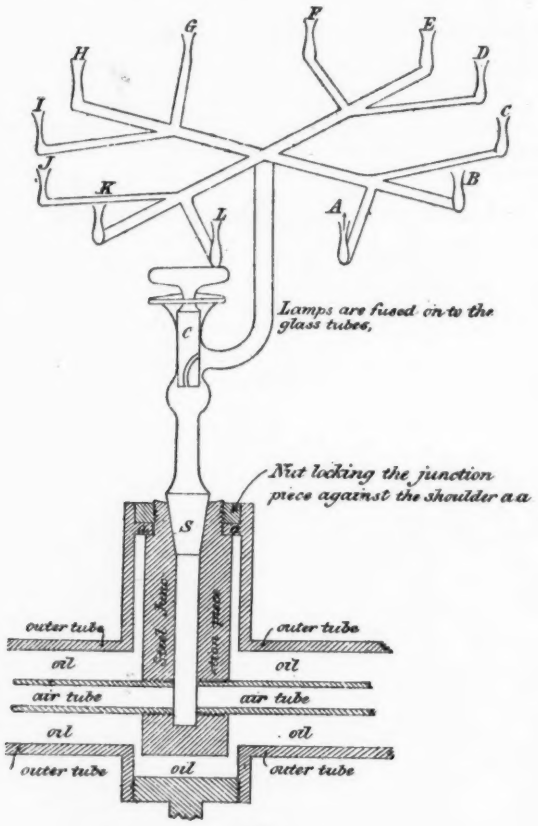


Fig. 6.

vacuum as *good* as that in the best, and *much better* than that in the worst of the glow lamps I examined; and that it is capable, in 20 minutes, of creating a vacuum *much better* than that in *any* of the lamps I had broken under mercury.

"That the system of pipes, cocks and glass stoppers is, for all practical purposes, perfectly air-tight.

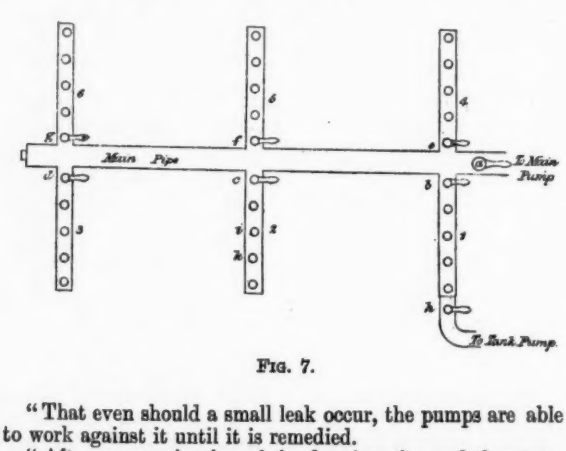


Fig. 7.

"That even should a small leak occur, the pumps are able to work against it until it is remedied.

"After an examination of the drawings for, and the structure of the pumps at No. 4, Huggin Lane, I am also of opinion:

"That they are well and solidly constructed, and not liable to get out of order.

"That, owing to the absence of heat, the slow movements of the working parts, and the unusual quality of the lubrication (due to the continual passage of small quantities of oil through the pump), the wear of the rubbing surfaces will be very slight indeed."

It is proposed to form a company in this country, not for the purpose of making these pumps, but for making lamps exhausted by the Berrenberg pump. We might mention that the pump has been used by the Beacon Lamp Company, of America, for a considerable period; but the pump exhibited at Huggin Lane contains all the improvements which Mr. Berrenberg has been able to devise from his long experience.

THE ISOLATION OF SOUTH AFRICA.

Once again, and we hope for the last time, we have had an object lesson, showing us the unsatisfactory state of our cable communication with South Africa. Possibly, when affairs are quite settled at the Cape, when our interest in the movements of the German squadron now lying in Delagoa Bay has died out, when the Ashanti expedition is on its way homeward, and when we are only liable to the average chances of embarrassment in Africa, these cable systems will have been restored to their normal state, and give the minimum of inconvenience to the public. But at the present stage, even when interruptions and delays in transmission are not of vital importance, it is none the less a subject calling for serious comment, when we learn that still another cable to the Cape has collapsed. We refer to the announcement that the cable from Delagoa Bay to Durban (Natal) was interrupted last Monday (20th). This is the fifth cable to South Africa which has become useless since Monday, the 13th, five breaks within one week, certainly not a record which can be called creditable to these routes, and quite as certainly a combination of failures which requires immediate attention and remedy.

We may here, without again going into the inconveniences which we dealt with fully last week, lay the present position clearly before our readers. By the breakage of the cables between St. Thomé and Loanda, which occurred on the 15th, the telegraph lines running to the Cape along the West Coast of Africa, are rendered quite useless as far as messages from England to South Africa are concerned. The breakdown of this Delagoa Bay-Durban cable has much hampered the telegraph route along the East Coast of Africa, which had been restored on the 4th of this month, by the repair of the broken Aden-Zanzibar cable. Messages can, however, still reach Delagoa Bay, in Portuguese East Africa, whence they may be sent on by landline through the Transvaal, but are subject to some delay. All that is now required to make this chain of unfortunate accidents complete, is either that the Aden-Zanzibar cable should break down once more, or that a recrudescence of the troubles in the Transvaal should again result in the closing of the landlines by President Kruger. In the event of either of these contingencies, neither of which is improbable, we would be quite ignorant of—but none the less would England be held responsible for—the untoward troubles which might arise. To take an illustration of the present circumstances, we find that a telegram sent by the *Times* correspondent at Pretoria to that paper breaks off abruptly in the middle of a sentence, and the following editorial explanation is given: "The conclusion of the above message has not yet been received, owing to an interruption of the Durban cable." This condition of affairs cannot be looked on as satisfactory, either to the Government or to the public. Recently, at the conclusion of negotiations for the extension of the financial assistance which the proprietors of this cable receive from Government, Sir John Pender was enabled to inform the general meeting of shareholders of the Eastern Telegraph Company "that arrangements just completed with the Cape, Natal, and the Transvaal, insure us 15 years' prosperous traffic." As far as the public is concerned, it would have been much more satisfactory to know that arrangements had been completed, which would insure 15 years of uninterrupted communication.

We have no desire to enlarge upon the recent failures, but the lesson which has been enforced upon us during the last

few anxious weeks should not be allowed to pass unheeded. Events have shown us that in trusting to the existing system of cables to South Africa we lean upon a broken reed. It must have been forcibly brought home to the various departments of H.M. Government, the Colonial Office, the War Office, and the Admiralty, that "something must be done." Obviously the first thing to do is to establish, as soon as may be, the line from Sierra Leone to the Cape, *via* Ascension Island and St. Helena. The strategic value of such a line has, we believe, long been recognised by the Admiralty, and possibly the Treasury may now realise its value. On the East Coast, the Eastern and South African Company should cease to trifle with the public, and duplicate at least their unfortunate Aden-Zanzibar cable. This company, as we have pointed out on previous occasions, receives annually from various governments (principally from H.M. Government) the sum of £88,000; and apart from such subsidy, has paid its shareholders such dividends as 18 per cent. and 19½ per cent. out of earnings. Altogether, the Government subsidies, guarantees, &c., received by both the existing routes to South Africa amounts to about £170,000 per annum; and still at a critical time we find that, as far as telegraphic news is concerned, South Africa is practically isolated.

CORRESPONDENCE.

The Geometrical Form of Transformer Plates.

Replying to Mr. Kemp's letter, in which he states that the transformer plate, fig. 1, in your issue of December 27th, has an advantage over the plate, fig. 2, on account of the smaller air gap resistance.

It must be noticed, however, that the magnetic lines produced in the central core of fig. 1 are twisted out of the plane of the central core plate at places where it overlaps the outer frame, and it is probable that the air-gap resistance is as great as in the case of plate, fig. 2.

For although the area for the passage of lines of force is greater in fig. 1 than in fig. 2, we have to consider the effect of the oxide or scale on the plates in resisting the flow of lines in fig. 1, in addition to the actual air gap.

With the latter type of plate, the advantage of laminating the core is to a great extent lost, and considerable loss by eddy currents is likely to occur at the overlapping portions; as the lines of force produced in the central core are not confined to one plane. Another defect inherent to transformers built up of plates, like fig. 1, is the greater length of the copper circuits required, as compared with transformers constructed with plates like fig. 2. In the former case, the plates do not come close together when clamped up, an air space being left between each plate in addition to the paper insulation, as a consequence, a greater length of copper wire is required, involving increased first cost, and loss of efficiency due to the greater $C^2 R$ losses.

George Adams.

January 14th, 1896.

Desulphurisation of Gold Ores by Ozone.

In your issue of 17th inst., you published a note on the "Desulphurisation of Gold Ores by Ozone," in which the idea is evidently ridiculed. It will, however, interest your readers to know that a patent ozone generator, in which I am interested, has been made by an eminent practical electrician, whose name is a household word in the profession, which enables ozone to be produced in quantities, heretofore impossible, and at a small cost.

Atmospheric air is forced through the apparatus and subjected, during its passage, to the action of a silent discharge of electricity at very high potentials, whereby the ozone is generated from the air acted upon.

Such an invention opens up enormous possibilities, but its practical use for the treatment of refractory ores to render them more amenable to the action of cyanide or chlorinisation, can only be determined by tests on a large scale, arrangements for which are being made. There is, however, no doubt as to the value of the invention as enabling cheap ozone to be applied to other industries, such as the bleaching of linen, cotton, silk and woollen fabrics, and of paper pulp; also for the purification and bleaching of oils, fats, waxes, &c., and for sanitary purposes, general purification and ventilation.

The new ozone generator appears to be as far ahead of the Siemens's tubes, and other known methods for the production of ozone, as the use of steam is in advance of wind as a motive force; but, as the invention is not yet generally known, the scepticism of the writer of the note in question may be excused. As you occupy so leading a position in the electrical profession, I shall be happy to arrange an exhibition in London of the apparatus for you at any time.

W. J. Engledue,
Colonel (late R.E.).

January 20th, 1896.

"Electronite."

We have read, with some amusement, your remarks in your issue of the 10th inst. with reference to the name of our new mining explosive, "electronite." We believe you are mistaken, both with regard to the name "electronite" which we have given to this explosive, and also to the motives which actuated us in selecting that name.

We had no intention to "drag in some reference to electricity in order to attract attention," or "to impress the vulgar mind," as you suggest. The word itself—which is electron-ite and not electro-nite, as you write it—is made up of electron, the Greek for amber, and the termination, "ite," is common to most of the new explosives. Thus the name is but a variation of "amberite," the name of our well-known smokeless powder, of which the new explosive is a variety.

We fail to see, moreover, how it can be called a "crass misnomer," and are also of opinion that it may be defended on philological grounds.

Curtis's & Harvey.

[We certainly hope that we "have been *mistaken*" with regard to the "motives which actuated" Messrs. Curtis's and Harvey in the selection of the name *electronite* for their new mining powder. But whatever may exist in their minds it is probable that the majority of people will associate the word with electricity and not with amber; that some will be attracted to it accordingly; whilst the more enlightened few will sneer at what they will consider a catch-penny title. Only a very few who have kept in touch with their lexicons and their Arnold will, we suspect, recognise a learned classic allusion. As to the philological accuracy of electronite, which Messrs. Curtis's & Harvey believe to be capable of being upheld because it is "a variation of 'amberite,' the name of our well-known smokeless powder" (than which a more hideous combination of English and Greek could scarcely be imagined), we should expect something very much more to the point than appears in their letter.—Eds. Elec. Rev.]

Incandescent Lamp Tests.

The tests hitherto published on the life and efficiency of incandescent lamps, of various manufacture, have little or no value for practical purposes, because, as a rule, the number of lamps used for such tests is much too small, and insufficient information is given regarding the reliability of the method of testing, and, consequently, cannot be taken as a criterion as to the properties or qualities of a certain make of lamp.

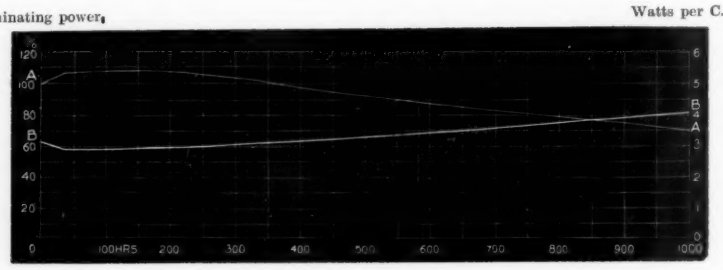
The lamp manufacturer alone knows best how many dozen lamps it is necessary to test, carefully watch, and re-test again and again, to obtain reliable information of a single make.

As it requires all his time and energy to initiate himself into the quality of his own article of manufacture, he can only spare sufficient time to make rough tests of his competitors lamps in order to keep himself generally informed regarding the state of the market, and it is, therefore, obvious that this would not enable him to publish responsible tests regarding "European" incandescent lamps.

Consequently an article, such as appeared in the Electrical Review, rarely, if ever, originates from the editor, but from a manufacturer who is anxious to advertise his own lamps.

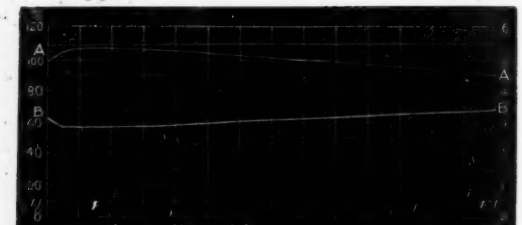
The article above referred to touches upon seventeen different makers of lamps, and the average results was obtained from tests of six lamps, a number which is wholly inadequate to even approximately indicate the quality of the lamps, and, furthermore, any data relating to the reliability of the tests are conspicuous by their absence.

The article concludes with the cautious remark not to judge the various makes from results obtained from one batch of lamps, and one series of tests, but the writer of the article should be congnisant of the fact that his caution to the general public would avail nothing, as the latter either overlooks or ignores it, and simply adheres to the published tables.



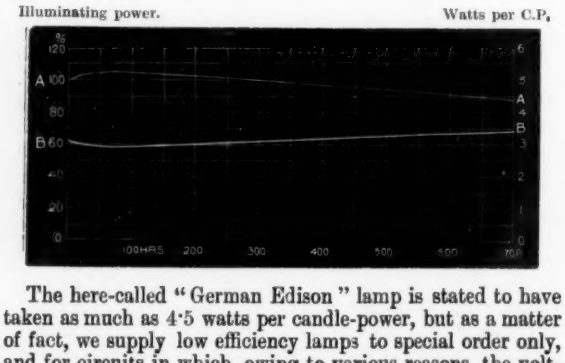
That others beside the general public do this is clearly proved by the fact that the article has been freely made use of for very doubtful advertising purposes.

We have up to now purposely avoided taking notice of any such publications, but cannot help doing so in the face of the unfair advantage taken by some makers, besides we consider it in the interest of the incandescent lamp trade generally, to point out the fallacy of such public tests, and with this end in view would ask you to afford us publicity for the three graphic curves annexed.



These curves relate to three series of 15 lamps each, which we manufacture as our ordinary lamps, *i.e.*, lamps taking 3·1 watts per C.P.

If the writer of the article wishes to be considered an expert, he should have known that a comparison of lamps of different makes, having various efficiencies, and consequently dissimilar in life, is absolutely valueless, which all important fact has not been considered at all.



The here-called "German Edison" lamp is stated to have taken as much as 4·5 watts per candle-power, but as a matter of fact, we supply low efficiency lamps to special order only, and for circuits in which, owing to various reasons, the voltage fluctuates to such an extent, that higher efficiency lamps would be subject to deteriorations out of proportion.

The general reader must come to the conclusion that all "German Edison" lamps consume 4·5 watts per C.P., but this is certainly not the case, as we make lamps consuming as low as 2·6 watts per C.P.

We, therefore, consider that our lamps have been tested under very unfair conditions.

As to the results obtained, as illustrated in the annexed curves, we would add the following:—The photometric measurements have been taken by a Lummiz-Brodhun photometer, and the lamps were compared to standard incandescent lamps, standardised at the Imperial Testing Institute, at Charlottenburg. The difference in the emission of light round the axis of the lamp, has, as a matter of importance, been duly taken into account.

The volt and ammeters used at the factory are of the well known Weston type, and have also been standardised, and are being constantly controlled by the Institute at Charlottenburg. The lamps used for the test (never less than 15) are fixed in a vertical position, and are kept burning at the voltage for which they are photometrically intended. The lamps are kept in circuit day and night, and the voltage is accurately maintained throughout the trial. The tests are taken at the beginning—every 24 hours, later at longer intervals—every 50 or 100 hours, and with each test the exact candle-power is measured at the correct voltage, thus the amount of watts per candle-power is determined.

The curves, A, show the variation of illuminating power in per cent. of the original, starting from the left hand side; the curves, B, show the variation in the consumption of energy, and start from the right hand side.

The Electrical Company, Limited.

Information Wanted.

Will you kindly tell me, through your correspondence columns, the amount and gauge of wire to put in wrought-iron fields of Manchester dynamo, 5 inches by $2\frac{1}{4}$, ring armature wound $4\frac{3}{4}$ lbs., No. 17 gauge, to give 50 volts; and also say how the calculations are arrived at.

Thanking you in advance.

Horace Vernum.

[To calculate the field magnets of this machine we should require to know the section of the armature core, the length and breadth of the air space between armature and field bore, the number of wires on armature counted all round outside, also average length of magnetic circuit.—EDS. ELEC. REV.]

Worthless Incandescence Lamps.

I have read, studied, and tried to understand the question of "Worthless Incandescence Lamps," which is so prominently brought forward by the *Daily Telegraph* and other papers. The gist of the subject, however, lies in the fact that the electric light consumer, in buying a lamp, cannot discriminate by any mark, sign, or shape between the foreign made lamps of inferior construction, which is the cheap importation now flooding our markets, and the reliable lamp which is of home manufacture, made by our own people.

The Merchandise Mark Act enforces, under its clauses, the proper marking of such articles. This is not done in the case of individual lamps, although the packing cases may be marked. The consumer is clearly defrauded, and is quite aware of the fact when he receives the bill and looks at the meter to check it. He says that he will have no more of the lamps "made abroad," but, when the supply is to be renewed, our friend is again deceived because the lamps are a penny or so cheaper, and are, externally, exactly like the best English makes.

"Penny wise and pound foolish" is here exemplified practically, and we, as consumers, have a right to demand an official test, based upon the report of an executive committee appointed by the legislature, as an Englishman only wants to get good goods for good money, and befriend his nearest kindred.

Mahendies.

January 22nd, 1896.

THE NORTHERN SOCIETY OF ELECTRICAL ENGINEERS.

PRESIDENTIAL ADDRESS BY MR. W. P. JAMES FAWCUS.

I MUST sincerely thank you for the honour you have done me by electing me your president. To follow in the footsteps of my predecessor, Mr. Edmunds, is no easy matter, but my connection with this Society from its commencement has been so intimate, and my friendship with a large portion of the members is such that my task will be easier than it might otherwise have been. The Northern Society of Electrical Engineers is eminently a practical Society, the whole of its members being actively engaged in their profession; you will therefore, no doubt, prefer me to confine my remarks to practical subjects. In the first place, I must congratulate the Society upon the extremely satisfactory progress it has made. The Society was formed two years ago for the purpose of hearing and discussing papers on electrical engineering subjects, and also to give the members an opportunity of meeting together more frequently to discuss commercial questions. Both these objects have been attained, and the Society has been supported in a manner which more than realises the expectations of the founders, all the leading electrical engineers in the district, and many from a distance, some even from London, having joined our ranks and taken part in the proceedings. On January 22nd, 1894, the inaugural dinner was held. At that time we had already 107 members on the books; at the present moment we have 145 members and nine associates. Since the commencement of the Society we have had read before us a number of papers, many of which have received very favourable mention, on account of their practical character. We have also promised to us for this session a number of what, I believe, will prove to be most interesting communications. The Society has served to bring together, to their great mutual advantage, many who might not otherwise have had an opportunity of meeting; it has, I believe, promoted a more healthy and friendly tone throughout the trade, and by constantly bringing together some who formerly looked upon each other only in the light of rivals, has promoted friendships, and in many cases established commercial relationships, and led to business being reciprocated between members of the Society, which would otherwise have gone elsewhere. I, myself, have experienced in no small degree the help and assistance of gentlemen whom, but for the Society, I should not have known, at all events intimately. There remains, however, in this direction, much to be done. We still have working amongst us, though I hope not members of our Society, many whose methods of obtaining business is by no means honourable or fair. Those who make false or misleading statements about the work of their competitors with a view to injuring them in their calling. Those who, by undertaking work at low prices, often using inferior materials and workmanship, cripple the business of others who are attempting to do work at a fair price. Those who, with an insufficient knowledge of the work they are undertaking, make mistakes costly to their clients, and often disastrous to themselves. These it is who destroy the confidence of the public in the honesty of the trade, and do much to retard the industry. It should be the duty of the members of this Society to use collectively and individually all means within their power to discourage such conduct. During the past year, although there have been no remarkable new developments in our science, much solid progress has been made. To my mind electricity has hitherto been too much associated with sealing wax and string; but I think we can congratulate ourselves that we now give as much attention to mechanical soundness as to electrical efficiency. In electric traction it is satisfactory to see the large number of schemes which are in the process of development, or in course of construction; there is little doubt that in the course of a few years the majority of the tramways in this country will be worked by electricity. The vast superiority of electric power for this purpose over either horse, steam, or cable traction, has been amply proved at all events to the minds of all thoughtful electrical engineers, although no doubt much remains to be done in convincing many of our municipal authorities. The stumbling blocks, so far, in the way of development in this direction have been the supposed unsightliness of overhead wires and the imaginary difficulties in the use of conduit systems. In the former case, the objections have arisen from the temporary character of work of that kind in the States, but the excellently arranged systems recently inaugurated at Bristol and Coventry have already gone far to remove these prejudices; and, in the latter case, the successful working of the new systems in operation in the United States and on the Continent, and the inventive efforts at present being devoted to the subject will no doubt shortly remove this difficulty also. It is very satisfactory to note that at Leeds both overhead and conduit systems are to be installed. The use of electrical transmission of power, especially in large works, is increasing rapidly, and I have no doubt a large amount of work, and I hope profit, will come to the industry from this source. Several demonstrations on a large scale have recently taken place of the saving to be obtained from this method of transmission, and the fact that these experiments have been satisfactory, is proved by the number of inquiries now coming in from all sources to the leading firms in this country for power plants. In these branches we have unfortunately, so far, been much behind our Continental and American competitors, but the engineers of this country are now thoroughly in earnest, and it will be strange if we cannot recover our lost ground and outstrip our rivals, as we have done in every other department of engineering industry. Perhaps the most satisfactory progress made during the last twelve months is in electricity supply works; not only have a large number of new undertakings commenced their operations, in most cases with great promise of success, but established works have enormously increased their load, it is also extremely satisfactory to notice the increase in the popularity of electricity as a heating and cooking agent, these uses will ultimately greatly help to increase the day load, especially if wisely encouraged by means of favourable terms being granted for current used for purposes other than lighting We have recently had read before us a paper by one of our members, Mr. Manville, in which he described the scheme which the Corporation of Swansea has in contemplation for utilising their generating plant for working the tramways, and so providing a magnificent day load. It is expected that it will be possible to sell electricity for this purpose at 2d. per unit. Should this expectation be realised, the impetus given both to electric traction and electric lighting will be very great, and the combination of lighting and traction schemes will become general. New rules were recently drawn out by the Board of Trade for the regulation of electric supply undertakings, but as these rules would, in the opinion of most central station engineers, have injuriously affected the industry, a large number of protests were lodged against their being put into operation without revision, with the result that the Board of Trade consented to hear the views of the objectors at a meeting held in London in November last. At this meeting, which consisted of the representatives of most of the corporations and companies owning electricity supply works, this Society, and the Institution of Electrical Engineers, were represented, and I am glad to be able to report that the objections to the rules were met by the Board of Trade in a most reasonable manner, with the result that the new rules when issued, while duly safeguarding the interests of the public, will not unnecessarily harass the undertakers. A step of great importance to engineers, especially those having charge of continuous current stations, is the introduction of high voltage lamps. At the present time, lamps are in use in several stations working at pressures of from 200 to 230 volts, and have proved themselves satisfactory when properly made. Those which have, so far, proved the best have two or more filaments arranged in series, no filament having to stand abnormal pressure; made in this manner, it is possible to obtain a good lamp for 230 volts as small as 8 candle-power, while a lamp of 16 C.P. can be made to run with pressures up to 400 volts. The possibility of obtaining lamps for such high voltages will, no doubt, induce engineers to gradually raise voltages within the premises of consumers; and here I should like to strike a note of warning. Although there may be no objection to using pressures up to 400 volts in public buildings or elsewhere, when the installation is under experienced control and the fittings are inaccessible to the public, for private houses and ordinary business premises where the inexperienced cannot be prevented from having access to the wires and fittings, 200 to 230 volts is quite high enough for personal safety. Even if there is no actual danger to life from the direct effects of a shock of from 250 to 400 volts—a question which is open to doubt—the indirect results of such a shock might be most injurious, or even fatal, if received by a delicate person or one in a dangerous position. It would be an evil day for the industry if, through the occurrence of fatal accidents to the general public, the electric light should again get the name of being dangerous, which, fortunately, it has now practically lived down. There is another reason why considerable caution should be exercised in converting existing installations from low to high pressures; the types of switches and other fittings commonly in use are totally unsuited to pressures much beyond what they were designed for, and in the case of some of the older installations, the insulation on the wires will be insufficient. Attention has recently been drawn to the subject of life and efficiency of incandescent lamps by the tables and correspondence which have appeared in the technical papers on lamp tests. It is surprising how few of the public, or even of practical electrical engineers, take the trouble to learn anything about incandescent lamps, when by using a little knowledge, easily acquired, on this subject, it may often be possible to reduce the cost of lighting to one-half. It is possible for the lamp manufacturer to produce lamps to suit a variety of different conditions, provided he is made aware of them, but as he seldom is furnished with any particulars beyond the candle-power and volts at which the lamps will have to work, he frequently has his lamps condemned as bad, when in reality there is nothing the matter with them, if used under proper conditions. In certain cases it may be desirable for the consumer to use a lamp which, although working at a comparatively low efficiency, will keep its full candle-power during its life; lamps of this type can easily be procured. In other cases it may be preferable, on account of the cost of energy, to use a lamp which will consume a minimum of current. In this case the consumer must be prepared to sacrifice either constancy of candle-power or duration of life; no lamp has so far been produced which combines a long life with high efficiency and constant candle-power. Again, it may be impossible to guarantee the regularity of the pressure at which the installation runs. Under these conditions an ordinary lamp would have a short life; but if the maker is made aware of them, he can specially construct one suitable. I have for the last few weeks been engaged on a series of experiments upon lamps of most of the leading English and Continental makers. During these experiments one or two interesting points, which may not be known to all of you, have come under my notice.

I have observed in the case of many lamps commencing their life with an efficiency of about 4 watts per candle-power (a very usual efficiency), that in the course of from 100 to 150 hours run, the candle-power has increased as much as 20 to 30 per cent., and the watts from 15 to 25 per cent., and has then gradually fallen until the end of their life. Installers should bear this point in mind, as the use of such a lamp in an installation where the plant had not a fair margin of power, might well lead to trouble through overloading. I have also observed that in some lamps commencing their life with an efficiency of from 2½ to 3 watts per C.P., no rise, or at all events, a very slight one was observable in the C.P. at any period of their life; but a steady and fairly rapid fall from the commencement until a critical period is reached at between 300 and 500 hours, when the lamps reach almost their minimum efficiency from 4 to 4½ watts per C.P., and continue in this state for the remainder of their life, which, in the case of some of the better lamps, has averaged considerably over 1,000 hours. This would point to the advisability of using a high efficiency lamp as such for a time, and subsequently moving it to a less important position for the remainder of its life; being content with about half its original light, it would then be no worse than an ordinary lamp of the lower candle-power. I hope in the near future it may be possible for supply undertakings to sell light to their customers, and not current; for only in this way will it be to the advantage of the engineer (generally the only person competent to come to a just conclusion) to see that the current is being consumed by suitable and efficient apparatus. It is somewhat an unsatisfactory sign that so much foreign material is being sold in this country, and is in many cases introduced and encouraged even by those who are striving in other branches of the industry to compete against it. British electrical engineers are now entering on a critical period of their existence; they are being threatened on all hands by foreign competition, and unless they wish their business to get into the hands of the Germans, they must not only strive to keep up the high reputation which English workmanship has always possessed, but must be prepared to support one another, by reciprocating business, and refusing to buy abroad when it is possible to obtain as good an article at home.

LONDON COUNTY COUNCIL.

Subways for Cables, &c.

The first meeting of the Council since the Christmas vacation took place on Tuesday last, the most important matter raised being the motion, to which we referred some time ago, set down by Mr. Walter Emden in relation to the underground distributing systems of various metropolitan companies. In order that no misunderstanding should occur, we reproduce the text of the Strand member's motion:—

"That it be referred to the Highways Committee to consider and report without delay on the expediency of the Council applying to Parliament for power for the Council and the local authorities to construct subways under the streets of London, for the reception of the tubes and wires of the gas, water, electric, and other companies, and to charge rents for the same."

Mr. Emden, in proposing his motion, submitted that it was desirable that the projected action should be taken. It would avoid loss to the ratepayers, and they would save money by reason of the roads lasting longer. He believed that a system of underground subways for that purpose could be made absolutely a remunerative undertaking, and that it would pay the water, gas and electric companies in making repairs. Major Probyn had pleasure in seconding the motion. Mr. John Burns, who considered that the mover of the proposal would not attain the object in view, impressed upon the Council the advisability of the Council obtaining powers to compel the various companies to place their tubes and wires in subways. Mr. C. Harrison, who, whilst sympathising with the motion, contended that the present policy of Parliament as carried out under the Land Clauses Acts would render the proposal too costly for the Council to put into effect. The motion was eventually adopted unanimously in an amended form, including the Parliamentary Committee in the deliberations on the subject.

Metropolitan Provisional Orders.

The following portions and recommendations of the Highways Committee were passed without comment:—

Three applications have been made to the Board of Trade for electric lighting provisional orders this session. Two of these are by the vestries of Battersea and Newington as regards their respective districts, and follow substantially the form in which orders have been obtained by other local authorities, and appear to require only very slight amendments. We recommend—

"That the Board of Trade be asked to insert in the Battersea and Newington orders the amendments prepared by the Highways Committee."

The third order, applied for by the County of London and Brush Provincial Electric Lighting Company and entitled the County of London (South) Order, relates to the St. Saviour's district and the parishes of Newington, Battersea, Lambeth and Camberwell. The district of St. Saviour is already included in the areas referred to in two other companies' orders, the parish of Newington in one, parts of the parish of Lambeth in two (while the vestry itself also has an order), and the parish of Camberwell in two. The Vestry of Battersea strongly objects to the granting of the order so far as relates to that parish; and it appears to us that ample provision is made under previous orders for the electric lighting of the district referred to in the order now asked for. We accordingly recommend—

"That the Board of Trade be asked not to accede to the application for the County of London (South) Electric Lighting Order."

Various applications for the laying of new mains were considered and approved; but, in regard to transformer chambers, it is interesting to note that the County Council, through its Highways Committee, is tired of kicking against the pricks.

We have considered a notice from the County of London and Brush Provincial Electric Lighting Company, under the County of London (North) Order, 1892, of intention to construct a transformer-box of large size at Windsor Terrace, City Road, in the position shown upon a plan, fowarded with the notice. Having regard to the decision of the Board of Trade upon the appeal against the Council's formal disapproval of the construction of large transformer-boxes in the public streets, we do not think that the Council should refuse its sanction to the construction of that referred to in the notice.

"That the sanction of the Council be given to the work referred to in the notice of the County of London and Brush Provincial Electric Lighting Company, upon the conditions prescribed by the award of the Board of Trade given on September 12th, 1895, viz., (*a*) that the said transformer-box be constructed in accordance with the drawing marked "F" attached to the award; (*b*) that there shall be no gas pipe within such distance from the box as is equal in feet to the diameter of the gas pipe in inches; and also to the further conditions that the company shall give two days' notice to the Council's chief engineer before commencing the work and that the box be constructed strictly in accordance with the plan submitted by the company.

LEGAL.

Woodhouse & Rawson, Limited.

In the Queen's Bench Division of the High Courts on Friday, Mr. Justice Vaughan Williams had before him the summons taken out by the Official Receiver and Liquidator of Woodhouse & Rawson United, Limited, asking leave, under Section 10 of the Companies' Acts, to proceed against the directors and auditors of the company.

Mr. Howard Wright, counsel for the liquidator, reminded his Lordship that when this matter came before the Court on May 16th last, the Court directed certain meetings to be held of the three classes of debenture-holders, to ascertain whether they desired to proceed or not. The result was that they decided not to proceed. Again the summons was adjourned to obtain the opinion of the debenture-holders as to whether they would forego their claims on any sums recovered as the result of proceedings instituted by the other creditors. After stating the results of the voting upon this question, Mr. Wright said that the first charge on the assets were the 6 per cent. debentures, and the 5½ per cent. debentures were a second floating charge. Doubts had arisen as to the rights of certain parties to vote; but the effect of inquiry on this point would be to increase, though not very substantially, the number desiring to institute proceedings. He had also to call attention to the letter of Mr. John Wood, holder of 6,000 5½ and 2,000 6 per cent. debentures, read at the meeting. It was dated October 29th, 1895; and in it he wrote that it seemed to him that the question of proceedings against the directors was one of a pure matter of business. He personally did not think very much would be recovered, and no benefit would accrue, except to the lawyers; but if there were people who thought otherwise, they would be prepared to pay a substantial sum to step into the position of the debenture-holders, and if a proposal of that sort were made to him he would consider it on its merits. So that he did not abandon his claims.

Mr. Macnaghten was about to address the Court for Mr. Wood and the other objecting debenture-holders, when

His Lordship said they might see whether this matter could be dealt with practically. Here were very serious charges against the directors. Facts had been laid before counsel, who had advised that those parties would be liable on those facts to contribute large sums to the assets of the company. Mr. Wood came forward and said:—"I do not believe these claims are worth anything; but it is not my habit to do anything—even to assist justice—unless I am paid for it, and I expect to be paid for it. If I am paid for it I shall be pleased, more than pleased, to assist." Very well; what was Mr. Wood's figure? His Lordship continuing, said: What I propose to do is to give Mr. Wood and his friends an opportunity of naming their price, and letting the unsecured creditors consider it.

Mr. Macnaghten submitted that in this matter it was not for them to name the price, but for the liquidator to make them an offer.

His Lordship: You say you have something to sell.

Mr. Macnaghten: Yes.

His Lordship: Well, you shall have an opportunity of selling it.

Mr. Macnaghten: Our position is perfectly intelligible. We do not think it is worth while bringing the action, but——

His Lordship: Well then, if it is not, it is not. But if your refusal to agree is only a commercial one, name your price, and I should say it ought not to be a big one. If these people do not want to sell because they wish to shield the guilty, I will not put them to the trouble of holding a meeting to consider their price.

Mr. Austen Cartmell, representing the 5½ per cent. debenture-holders, pressed the Court to direct that proceedings should be taken.

His Lordship said that the right thing to do was for the Receiver for the debenture-holders to put their interest in these claims against the directors and auditors up to auction and for the liquidator to buy, with directions as to the proper conditions.

For this purpose his Lordship again adjourned the summons.

THE GULCHER (NEW) ELECTRIC LIGHT AND POWER COMPANY *v.* MURRAY.

IN the Chancery Division of the High Court, on Thursday, last week, before Mr. Justice Vaughan Williams, application was made by the liquidator of the above-named company for an order of the Court calling upon Mr. James Murray to pay calls upon 300 preference shares, which it was alleged had been duly allotted him in the company. The respondent admitted that he agreed to take the shares, but only upon conditions that at least 10s. was paid up on an issue of preference shares. He urged that the conditions precedent had not been carried out, and that therefore he was not liable.

His LORDSHIP delivered judgment at some length on the following day, January 17th. He discussed the correspondence which had passed upon the subject, and also the circumstances connected with the whole affair, and stated that under the circumstances he thought Mr. Murray was not liable, and that the claim against him failed.

In reply to a question by Mr. MARTELLI, his LORDSHIP said that he did not think that he ought to order the liquidator personally to pay the costs. If there were assets enough, the respondent would get them.

Mr. GORE BROWN thought the assets would prove ample for such payment; and that, as this was the last incident in the winding-up, it would not be long before payment was made.

TRADE MARKS' INFRINGEMENT.

AT the Central Criminal Court on Monday, 20th inst., before the Common Serjeant, Edward Augustus Ingold, 30, engineer, and Alfred Attride, 34, horse trainer, who surrendered, were indicted under the Merchandise Marks' Act for falsely applying, or causing to be applied to certain electric lamp-holders, a mark so nearly resembling the trade mark of the Edison & Swan United Electric Light Company, Limited, as to be calculated to deceive.

Mr. Charles Mathews and Mr. C. F. Gill conducted the prosecution on behalf of the Edison & Swan United Electric Light Company, Limited; Mr. Schultess-Young defended Ingold, and Mr. A. Hutton and Mr. Collison defended Attride.

It was alleged, on the part of the prosecution, that at about the beginning of 1895 Ingold made arrangements for a large number of electric lamp-holders to be made in Germany, and sent over to this country. The lamp-holders, having been made in Germany, were sent over here, and Ingold thereupon caused them to be stamped with a mark containing the words "Edison, and Swan," and other words, and they were then sold. Ultimately the Edison & Swan United Electric Light Company, Limited, found that lamp-holders were being sold at a price lower than that at which lamp-holders made by them were sold, and they thereupon caused inquiries to be made, and then commenced this prosecution. It was contended, on the part of the prosecution, that the mark stamped on the lamp-holders which were made for Ingold in Germany, so nearly resembled one of the trade marks of the Edison & Swan United Electric Light Company, Limited, as to be calculated to deceive.

The prisoners gave evidence in their own defence.

Witnesses were called to speak to the good character borne by the prisoners.

Mr. HUTTON addressed the jury for the defence of Attride. He contended that Attride was an innocent agent in the matter.

Mr. SCHULTESS-YOUNG, on behalf of Ingold, argued that the mark which Ingold caused to be stamped on the lamp-holders made for him in Germany was not a colourable imitation of the Edison and Swan United Electric Light Company's trade mark. He contended that Ingold had throughout acted in good faith.

The jury found Ingold guilty; they found Attride not guilty, and he was discharged.

George Cosgrave, 22, engineer, who also surrendered, pleaded "guilty" to an indictment charging him under the Merchandise Marks' Act with applying, or causing to be applied, to certain electric lamp-holders a mark so nearly resembling the trade mark of the Edison & Swan United Electric Light Company, Limited, as to be calculated to deceive.

Dr. Cooney appeared for Cosgrave.

Mr. CHARLES MATHEWS, on the part of the prosecution, asked that Cosgrave might be liberated on his own recognisances to come up for judgment if called upon. In the course of 1895 Ingold had 13,000 of the lamp-holders delivered in London from Germany.

The COMMON SERJEANT said he should release Cosgrave on his own recognisances in £100 to come up for judgment if called upon.

Cosgrave entered into that recognizance and was released.

The COMMON SERJEANT sentenced Ingold to nine months' imprisonment without hard labour.

BUSINESS NOTICES, &c.

Action Dismissed.—On 17th inst. the case of the Brighton Corporation *v.* Thomas Walker came before the Brighton Borough Bench. Walker was charged with laying a lead at 56, London Road to communicate with the Corporation electricity supply service mains between September 13th and October 29th, without obtaining the Town Council's consent. Evidence having been given, the summons was dismissed with costs, the stipendiary remarking that a quasi-criminal offence was charged, and he was satisfied that no jury would convict.

Bankruptcy Proceedings.—An application for an order of discharge was made to Mr. Registrar Giffard, sitting at the London Bankruptcy Court, on the 16th inst., by Walter Andreae, electrical engineer. The Official Receiver presented his report, and after hearing Mr. Muir Mackenzie in support of the application, his Honour upheld the report, but said he did not regard it as a serious case, and it would be sufficient to impose the minimum suspension of two years. Order entered accordingly.

Business Announcement.—The Consolidated Telephone Construction and Manufacturing Company announce that their offices and works have been separated and removed from 109, Farringdon Road. The offices, show-rooms, and engineering staff are now at 186 and 188, Shaftesbury Avenue, W.C. Communications for the works should be addressed, Telephone and Electrical Works, Coventry.

Liquidation Notices.—At meetings of the members of the Bernstein Electric Lamp Company, Limited, held at 10, New Court, Carey Street, London, on December 27th, 1895, and January 14th, 1896, it was resolved to wind up the company.

Carborundum.—From Mr. J. S. Flanagan, of 52, Queen Victoria Street, E.C., we have received a leaflet containing a reprint of an article from the New York *Sun*, describing carborundum, the new product of the electric furnace, to which we have already referred, and its manufacture at the Niagara works. We understand that details respecting the English company operating the patents for the United Kingdom can be obtained from Messrs. E. M. Cole and Alfred Thompson at 20, Bucklersbury, E.C.

Change of Address.—The Southgate Engineering Company, Limited, have removed their London office from 172, Fenchurch Street to Leadenhall House, Leadenhall Street, E.C. This office will be under the management of Mr. Jas. Reid.

Guilty.—At the Central Criminal Court, last week, an employé of Messrs. Nalder Bros. & Co., named Whelan, was sentenced by the Common Serjeant to six months' imprisonment, with hard labour, for defrauding his employers by forgery, and in other ways. The Common Serjeant dealt with the case as one of embezzlement, and not as one of forgery. It was a very serious offence, and he would pass such a sentence as would have the effect of deterring others from acting in a similar manner. The total defalcations were between £30 and £40.

Messrs. Marshall in India.—The *Indian Planter's Gazette* recently contained an article describing the Calcutta branch of Messrs. Marshall, Sons & Co., Limited, engineers. The progress made by the branch during the five years it has been in existence is noted. From two small rooms, which were sufficient five years ago, the establishment has grown so as to necessitate a large frontage of buildings in Clive Street, and in these premises our contemporary remarks, "the electric light is everywhere." The electric light department contains a 10-H.P. steam engine and a loco. pattern boiler, which drive a dynamo, and from this 100 lights of 50, 32 and 16 C.P. lamps are supplied. Anyone reading the article in question cannot fail to be impressed with the great strides with which the Calcutta branch of this ancient business house has advanced, and taken hold of the Indian market.

Personal.—We understand that Mr. L. Pyke, late of Messrs. Pyke, Harris & Co., Limited, of Westminster, has sent in his resignation to that company, as managing director, owing to his having entered into partnership with Mr. Owen Lucas and Mr. Leopold Lucas, under the title of Messrs. Owen Lucas & Pyke, as consulting engineers.

Pocket Catalogue.—The Electrical Power Storage Company, Limited, has just issued a new edition of its pocket catalogue. A most interesting feature of this extremely neat production (which measures only 5 inches × 3½ inches), is that it contains the whole of the company's ordinary trade catalogues, together with one or two useful tables placed at the end of the book, which relate to fuses, resistance of wires, acids, &c. Only one side of each sheet is printed upon, the back page being ruled off for taking notes, noting dimensions, &c., and the general uses of a pocket-book. The great quantity of information included in so small a book has, of course, necessitated very small type and illustrations; nevertheless, everything is very distinct and clean. We understand that the first edition of this catalogue, which was issued about 18 months' ago, was quite exhausted within a couple of months, and unless the present edition is a much larger one, we venture to predict that it will soon run out, for the book cannot fail to be very useful.

Sell's Directory of Telegraphic Addresses.—We have received a copy of Sell's directory of registered telegraphic addresses for 1896, this being the eleventh year of its publication, and the third year in its practically complete form, as compiled from official lists supplied by the authority of the Postmaster-General. Upwards of 12,000 new registrations, cancellations, and other alterations have been received from the Post Office, in addition to an enormous number of trades, professions, and telephone numbers included in the alphabetical lists; making together upwards of 30,000 individual alterations. The fact that the 50,000 firms whose names appear transact sufficient business to render it necessary for them to register abbreviated telegraphic addresses at the Post Office for the convenience of their correspondents, renders the list in this book exceedingly valuable. The book contains all but a small percentage of the telegraphic addresses which are registered with the Post Office in every part of the United Kingdom. Among the subsidiary contents of the volume is a short and concise description of the various cable systems, together with a tariff of charges

for cablegrams to any part of the world, and a list of firms classified under their trade headings. The National Telephone Company have furnished particulars of telephone numbers. Information relating to the prices charged for a three minutes' telephonic conversation between town and town and city and city is published for the first time.

The Year 1895:—

Allgemeine Elektricitäts-Gesellschaft.—According to this company's report (*Geschäftsjahr*, 1 Juli, 1894, bis 30 Juni, 1895) the business of the Allgemeine Elektricitäts-Gesellschaft, which is represented in this country by the Electrical Company, Limited, Charing Cross Road, has been for the past year characterised by the development of past achievements in the field of practical electricity, rather than by the introduction of epoch making improvements. The extension of electric lighting has been very great, notwithstanding the advances made by other forms of lighting, and the advantages of electric power transmission appear to have opened up new paths for certain industries, especially those in which small motive power is required. The Drehstrom system, first introduced by the A. G., has taken a first place in the utilisation of the great natural sources of energy by long distance transmission. Electric railways appear to have come greatly into favour with municipalities and the public, since their great superiority to animal traction has been discovered. The number of employés of the A. G. have increased during this year from 3,385 to 5,121. 2,049 dynamos and motors, having a total capacity of 30,000 H.P., have been turned out of their workshops, and, at the end of the year, orders were in hand for more than 2,000 dynamos, having a total capacity of 80,000 H.P., 26 of these machines being over 1,000 H.P. The number of electric street railways, either working, or in course of construction on the A. G. system, increased from 19 to 29, and in length of track from 195 km. to 383 km., and the number of motor cars from 350 to 680. The power stations of these street railways had increased in capacity from 5,950 H.P. to 11,230 H P. It is stated that the great central station on the upper Spree, for supplying Berlin with light and power, will probably be finished next summer. There is already every sign that the demand, with the exceptionally low tariff, will be very great. The plan for this station allows for an extension, if necessary, to a capacity of 50,000 H.P. The electro-chemical works at Bitterfeld have been got into satisfactory working order on a very large scale, after many difficulties have been encountered and overcome. The products have found a ready sale, and the output was doubled during the year. The above gives a sketch of a few of the more striking advances made by this large and successful electrical company during their past business year. A favourite policy with the A. G. appears to be to construct and work for some time large municipal electrical works, and then to sell them as a going concern to a company or the municipal authorities. If this is found to pay as a voluntary transaction, there should not be much objection to the legal compulsion, which applies to many similar undertakings in this country.

The Shillingford Works Company, Limited, report that, during the past year, their business in Geipel's steam traps has rapidly increased, and that they are now turning out at the rate of 2,000 traps per annum. During December the orders exceeded 200 traps, one order alone being for 108 traps. We are informed that Prof. Kennedy, Mr. A. E. Seaton, Mr. T. Mudd, Messrs. Babcock and Wilcox, and the engineers of several important electricity supply stations, have testified to the excellent working of this trap.

The New Fittings Works at Kempston.—We understand that the Crystal Electric Lamp Company is rapidly getting into working order at the Kempston Works, and a dinner was recently given at the Bedford Town Hall to the staff and a party of visitors.

Workshop Lighting.—In a recent issue we stated that the workshops of Mr. John Hall, of Bradwell, had been lighted electrically. We understand that Messrs. Webster, Michelson & Co., electrical engineers, of Dudley, supplied the dynamo. They have supplied a good number of dynamos during the year 1895.

ELECTRIC LIGHTING NOTES.

Aberdeen.—The Lighting Committee has decided to make a further experiment with electric lamps in the streets by erecting two in Bridge Street.

The question as to lighting the quays by electricity, and the probable cost, has been referred to a committee of the Harbour Board.

Belfast.—The works of Messrs. M'Laughlin & Harvey are lighted by electricity. Recent extensions have been carried out by Mr. J. H. Greenhill, of Belfast, bringing up the present number of lights to two 3,000-C.P. arc, 110 16-C.P. incandescent, 25 25-C.P. incandescents, and four 200-C.P. sunbeam lamps. The engine and dynamo were laid down by Mr. Greenhill.

Brazil.—In our last issue we stated that Messrs. Siemens and Halske are putting down an electric lighting station for lighting Maceio as well as other towns. We are informed that this statement is incorrect, as the complete electrical equipment for the station at Maceio has been supplied and erected by the Brush Electrical Engineering Company, through their agents at Rio de Janeiro. The lighting at Maceio was successfully inaugurated on January 15th, 1896.

Brighton.—The Town Council has approved the report submitted by Mr. Wright, *re* electric lighting extensions, which we abstracted in our last issue.

Bristol.—We understand from a local newspaper that it is more than probable that at the March Council meeting the Electric Light Committee will ask sanction for a somewhat large extension scheme.

Camberwell.—The application of the County of London and Brush Company for a provisional order for lighting Camberwell is not to be opposed by the Vestry.

Cardiff.—In the next half-year's estimates, the borough engineer reckons £848 for profit on the electric lighting undertaking, which will be nearly sufficient to repay principal and interest for the six months.

Colchester.—The Town Council met on 16th inst. to consider the question of public electric lighting. The Committee presented its report *re* site, and stated that a letter had been received stating that the War Office will be prepared to take a supply of electricity for the new military hospital. About 500 lamps would be required, and 6d. per unit was proposed by the War Department. The War Department is also to be asked whether they will require light for the new Infantry Barracks, which would need about 750 lights. The Committee had been in communication with Mr. W. H. Massey regarding the cost of plant, &c., and his report was read. He had already submitted a report in May, 1894. He mentions two schemes—a £13,000 and a £20,000, but does not recommend street lighting, save out of profits.

Edinburgh.—The Town Council is to be recommended by a Committee that the City Chambers and Royal Exchange be lighted electrically at a probable cost of £256.

Eston.—The District Council has resolved to advertise inquiring the cost of an electric light installation for the district, and also the annual maintenance cost.

Exeter.—A Local Government Board inquiry has been held into the application of the Council to borrow £11,000 for the purpose of taking over the works and plant of the Exeter Electric Light Company. Dr. Fleming, who advised the Council as to the purchase, stated that he had made a complete inspection of the company's plant and buildings, and he advised that they should be purchased by the Corporation. He believed the undertaking could be worked by the Council and show a profit. He thought the valuation of £7,500 was a fair one, but he considered that the company, having only been in operation for about five years, could give no figures as to the correct value of the concern. No part of the plant had any value attached to it, unless it was in full working order. A new station could not be established for less than £10,000. The fair market price to pay for the plant would be £7,110, to which he added £426 as the cost of obtaining a provisional order. When he said that a new station would cost £10,000, he did not include the value of land and buildings. Mr. Pitt Lewis, Q.C., opposed on behalf of several ratepayers.

Glasgow.—On December 26th, the treasurer to the Corporation reported the collection of electric light rents as follows:—1895-96, £5,389 8s. 5d.; 1894-5, £5,221 18s. 5d.; increase, £167 10s. Several members complained about the small increase. The increase in the gas consumption amounted to £2,149 odd.

Hampstead.—Owing to a recent failure in the supply, some negatives and plates, the property of Messrs. Dellagana & Co., of Gayton Road, were spoiled, and the firm claimed compensation. They have now withdrawn the claim.

Hanley.—The local press states that the first year's working of the electric light in Hanley "establishes a record," and compliments Mr. Lobley, the borough engineer and surveyor, and his assistants, upon the success of the undertaking. The accounts for the year ending December 31st show that the revenue amounted to £3,724 3s. 8d., and the expenditure to £3,623 17s. 1d., leaving a balance on the right side of £100 6s. 5d. The actual working expenses amounted to only £2,286. The total sum expended is made up by two important items, viz., £754 8s. 10d. for interest, and £587 18s. 10d. to account of principal repaid. The total amount of loans sanctioned by the Board of Trade for electricity works is £46,110. At the close of 1894 the amount borrowed (at 3 per cent.) was £21,645. At the end of December last this amount had been increased to £32,363, and this capital has been expended. A margin of £13,747 remains available for further extensions. The principal items of revenue were—electricity supply, £3,444; meter rents, £75. The profit, before setting aside depreciation, was £1,443. The price charged in Hanley last year was 6d. per unit with 5 per cent. discount on prompt payment. The average price obtained is stated at 4·58d. Regarding cost of production, the following are the principal items: Coal, £560—being at the rate of ·74d. per unit supplied to customers; oil, waste, and other engine stores, £191, or ·25d.; wages, £1,467, or ·62d.; repair and maintenance, £359, or ·48d.: rents, rates, and taxes, £118, or ·16d.; management, including salaries and all charges, £413, or ·55d. The number of lamps fixed is 11,930, and the number of units sold last year was 180,000.

Italy.—A syndicate is about to put down plant to utilise the water-power of the river Adda near Milan, for the generation of electrical energy.

Kirkcaldy.—At the last Council meeting, a councillor moved that a committee be appointed to inquire regarding the advisability of lighting Kirkcaldy electrically.

Llandudno.—At the last District Council meeting it was proposed that Messrs. Kincaid, Waller & Manville be asked for a report *re* electric lighting, for a fee of 30 guineas. It was, however, resolved to inquire the fee of Mr. W. H. Preece, and if necessary, that of Dr. John Hopkinson.

Llandrindod Wells.—Mr. Jevons, of Birmingham, to whom the electric lighting contract was recently awarded, has replied stating that he would be prepared to lay the conductor underground, as suggested, but the term of contract would have to be for seven years. In a subsequent letter he forwarded a draft agreement, setting forth the conditions attached to the proposal, which were to the effect that the contractors would provide electric current, conductors, lamps, and fittings for 70 lamps of 32-candle-power each, in return for a payment of 55s. per lamp per annum, payable monthly, and also 3s. 6d. per lamp yearly for the renewal of the incandescent lamps, the contract to continue for seven years. The Council were to provide all lamp-posts in the positions required, and maintain the same in good condition. The Council came to the conclusion to write to Mr. Jevons, and state that they were not prepared to pay 55s. annually for each lamp, nor to provide the 20 extra columns required, also calling attention to other details. A special meeting is to be held to consider the reply when received.

London.—The St. James's Vestry has decided, on the recommendation of the Works Committee, that the following thoroughfares in the parish be lighted with the electric light:—Regent Street, Piccadilly Circus, Shaftesbury Avenue, Coventry Street, Lower Regent Street, Waterloo Place, Pall Mall, St. James's Street, and Piccadilly, and that it be referred back to the committee to take the necessary steps for carrying this proposal into effect. It was stated that the St. James's and Pall Mall Electric Light Company would keep each lamp lighted and in repair for £30 per annum. The lamps will be erected in the centre of the street, and placed 60 yards apart, and distributed as follows:—Regent Street, 16; Piccadilly Circus, 6; Shaftesbury Avenue, 4; Coventry Street, 2; Lower Regent Street, 5; Waterloo Place, 3; Pall Mall, 8; St. James's Street, 8; and Piccadilly, 8.

At a meeting of the City of London Tradesmen's Club last week, there was a discussion regarding the electric light in the City, and the cost thereof.

Loanhead.—A Committee has been appointed to inquire as to the practicability of laying down an installation for electrically lighting the burgh.

Mile End.—The plans, &c., of Mr. B. H. Jenkinson *re* the proposed electric lighting of the Institutions under the control of the guardians, have been referred to the Works Committee with full power, "except the expenditure of money and the entering into contracts."

Merthyr.—At the District Council meeting on 15th inst., the Parliamentary committee reported having met Mr. J. C. Howell, of Llanelly, the promoter of the provisional order for lighting Merthyr with electricity, who agreed to make provision for lighting one mile instead of half that distance.

Mill Lighting.—Electric lighting has just been applied to outdoor industrial purposes in the Ballochmyle quarries, Mauchline, Ayrshire. Six 2,000 C.P. arc lamps light the quarries to enable the work to continue by day and night. Some outer sheds are lighted with about 30 incandescent lamps. Messrs. Paterson and Cooper are responsible for the installation.

Maidstone.—The Electric Lighting Committee has presented a report recommending that the Council's provisional order be handed over under agreement to a private company to be formed by Mr. T. King. The consideration of the report has been deferred.

Oldham.—A report has been submitted by Prof. Kennedy dealing with the proposed extension of the central station at Rhodes Bank and the plant there. Prof. Kennedy recommended that the electric light station should be completed according to the original design, as it would be obviously inadvisable to make any smaller extension than that. The station, when so completed, would be big enough to contain four additional large steam dynamos, each capable of keeping 6,000 lamps alight at once. With one large and one small unit in reserve, it would be able to deal with about 28,000 lamps of 8 C.P. alight at once, or about double that number wired, and it would therefore be large enough, so far as buildings were concerned, to serve the committee for a long time yet. The boiler house should be extended as already planned. For the present extension to plant, the professor thought it would be best to add one Lancashire boiler, with an additional feed pump, and all the necessary pipes, &c., and two steam engines and dynamos, each of about 360 horse-power, with all the necessary steam pipes and the additions to the electrical appliances on the switchboard. He estimated that the cost of the new boiler and setting, pumps and pipes, two steam dynamos, extensions to switchboard, new condensing plant and shifting of the condenser, and air-cooling arrangements, would be between £7,500 and £8,000. That was at the rate of £11 per indicated horse-power, whereas the cost of the original plant at the station was £25 3s. per indicated horse-power, and the total cost of the extended plant now in the station was about £15 13s. per indicated horse-power. The cost of the original buildings was about £5,000, and the extensions would be of about equal magnitude, so that for present purposes it would probably be sufficient for the committee to take the price as being the same. The committee has accepted Prof. Kennedy's recommendations, and given instructions that he should prepare a full and detailed extension scheme, and a complete estimate of the cost.

Midsomer Norton.—Two electric lighting companies having applied to be allowed to light the town, the District Council has resolved to advertise for tenders for the work.

Pembroke.—Mr. J. C. Howell, Llanelly, has offered to light Pembroke by electricity, the cost being stated as £2 10s. per lamp of 16-candle-light.

Spain.—A central electric lighting station is being established at Malgrat. The central electric lighting station in the town of Malaga has been acquired by Messrs. Siemens & Halske, of Berlin, who intend to greatly enlarge it. A concession has just been granted for the electric lighting of Erandid y Deusto.

Surbiton.—The Electric Lighting Committee received six tenders for electric lighting: from the Capital and Counties Electricity Supply Company; Siemens Bros. & Co., Limited; Brush Electrical Engineering Company, Limited; Crompton & Co., Limited; Sharp and Kent, and Messrs. Fowler & Co. The tenders have been referred to Dr. John Hopkinson.

Saltash.—The lighting question came before a ratepayers' meeting on 18th inst.

Temporary Installation.—At the *conversazione* of the London Scottish Rifle Volunteers on Thursday, the 16th inst., to which we referred last week, a temporary installation of 300 16-C.P. lights was carried out by Messrs. Lovelock, Seabourne & Lee, and gave great satisfaction, not a single light failing during the evening. A very pretty effect was caused by the addition of coloured lights placed amongst the palms round the central platform. Other lights were artistically arranged amongst the draperies and alcoves. The same installation will do service on the occasion of the Cinderella dance of the same corps on March 27th, and also the annual ball of the Metropolitan Police of the A Division in February.

Wigan.—It was reported at the last Borough Council meeting that the engineer had sent out applications for tenders for plant to the following:—Messrs. Fowler & Co., The Corlett Electrical Engineering Company, Messrs. Mather & Platt, The Brush Electrical Engineering Company, and Siemens Bros. & Co.

Yarmouth.—The electric light report for the year 1895 shows a deficit of £450 for that period. The excess of the Corporation expenditure for electric lighting as compared with gas was about £250.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Baker Street-Waterloo Proposed Electric Railway.—We learn that the engineers to the authorised Baker Street and Waterloo Electric Railway have deposited with the Private Bill authorities of the House of Commons an estimate of the cost of the proposed extension of this railway to the St. John's Wood terminus of the Manchester, Sheffield and Lincolnshire Railway. They estimate that the further length of line required will be one furlong seven chains, and that the cost of construction will be £99,043. Of this sum, £62,568 will be expended in tunnelling, £15,000 upon the construction of a terminal station at Melcombe Place, and £12,000 upon the acquisition of the necessary lands and buildings.

Birmingham Electric Trams.—The Public Works Committee of the City Council considered, on 20th inst., the question of the proposed overhead electric system of tram service on the Nechells and Duddeston route, and formulated a report which will be presented at the next meeting of the Council.

Dover Tramways.—At the Working Men's Institute on 15th inst., Mr J. Bavington Jones read a paper on "Proposed Tramways for Dover." Electric traction was dealt with at considerable length, and the discussion which followed naturally went in that direction.

Dublin Electric Tramways.—The report just issued by the directors of the Dublin United Tramways Company contains the following:—"We are making application to the Privy Council for an order to authorise some extensions of our lines in districts where we think the traffic will warrant them, and are asking the local authorities to approve of the extensions. We are also asking the Corporation and the Commissioners of Rathmines and Pembroke Townships, who objected to the electrical clauses in our Bill of last year, which has passed the House of Commons, to consent to the reinstatement of these clauses when the Bill comes before the House of Lords, on terms which would permit of the use of electricity by mutual agreement hereafter."

Electric Traction in Germany.—The municipal authorities of Solingen have decided upon the construction of eight lines of electric tramways in the town. Work has just been commenced on the construction of an electric tramway in the town of Kiel. The necessary surveys have just been completed in connection with the projected electric tramway between Hamburg and Altona. Negotiations have just been completed between the Stettin Tramways Company and the Allgemeine Electricitäts Gesellschaft, of Berlin, for the conversion of the horse tramways in the town of Stettin into electric lines. The work has to be completed within 18 months, and is estimated to cost £175,000. A proposal is under consideration for the construction of a network of electric tramways in the Eschweiler district.

Electric Traction in Spain.—Plans are being prepared by the authorities of the Bilbao-Santurce electric tramway for a projected branch between Luchana and Ortuella.

Experiments with Traction Systems.—At the meeting of the Liverpool United Tramways Company, Limited, held on Saturday last, at Liverpool, Sir David Radcliffe, chairman of the company, stated:—"You are aware that we have had in contemplation for a considerable time past a change from horse haulage to mechanical haulage. We have tried the steam locomotive, compressed air, and electric haulage by means of the accumulator system. Steam would pay, but the Corporation have always felt that it was not a permissible system to adopt in a beautiful city like Liverpool. Compressed air was found upon trial to be far more costly than horse haulage, and in long runs, the running became very feeble before it got to the end of its journey. Although upon starting the air had been compressed to a pressure of 800 lbs. to the inch, yet the volume of compressed air that we were enabled to carry was not sufficient to last as a motive power for eight miles, and some of our in and out journeys are even longer than this. It had to be abandoned, not only on account of its ineffectiveness, but because commercially it was proved to be much dearer than horse-power. Electricity applied by means of the accumulator system was next tried, and the company who kindly made the trial proved that the work could be well and effectively done, but in the end they removed their cars, and sent an estimate of the cost of haulage alone, which exceeded by 15 per cent. our present system of haulage. In addition to this, they made it a condition that we should pay for every car such a sum of money as would have required additional capital to the extent of £368,000 in order to equip our system with those cars and the machinery they carried. Then at one time we approached the Corporation with a view to our laying down the cable system, but the conditions discussed were very onerous, and seemed to us to put the adoption of the cable system out of the question."

Electrical Engineering in Hungary.—Work is at present in hand on the establishment of a somewhat interesting plant at the ironworks at Reschitza, of the Austro-Hungarian State Railway Company, in connection with some new blast furnaces. All the air-blowers, which are of the Enke type, in connection with these furnaces, are each to be operated by a 15 H.P. "Drehstrom" electromotor. The contract for the supply of the generating plant and motors is in the hands of Messrs. Siemens & Halske, of Berlin.

Electric Traction in Italy.—The Società Roma dei Tramways e Omnibus has applied for permission to convert the horse tramway running between the Porta Sia and the Porta Sant 1 Agnese, Rome, into an electric line. A concession has been granted for the establishment of a system of electric tramways in the town of Cagliari.

Halifax Tramways.—The Town Council discussed the other day a proposal by a private company to construct tramways in Halifax. Mr. Parrish, electrical engineer, in answer to questions with respect to the scheme, said he did not think tramways would pay in a borough where the population was under 100,000, but in this instance they intended to extend the scheme to the outlying districts, and then it would pay. They were willing to enter into an undertaking to put Elland in the Bill next year, and they were thinking seriously of going to Huddersfield. The question of municipalisation *versus* private companies was considered. The discussion was adjourned for the purpose of giving the ratepayers an opportunity of expressing an opinion.

Leeds Tramways.—Seven members of the Highways Committee, who did not come up to London with the Tramways Subcommittee to inspect the Westinghouse model of electrical traction, visited that company's office on Thursday. Like their colleagues, they were favourably impressed with what they saw. The Highways Committee met last night, when the matter came up for discussion.

Newcastle Tramways.—On 15th inst., after the Corporation meeting, at which was presented the report of the deputation who visited the Bristol tramways, a public meeting of the ratepayers, presided over by the Mayor, and attended by several aldermen and councillors, was held at the Town Hall for the purpose of considering whether or not the tramway system needed improvement, and whether cable, electricity, or any other power should be used. The proceedings were very noisy throughout, and the majority of those present were opposed to any alteration. The matter ended, however, in a solicitor demanding a poll, and this is to be taken, and according to the Newcastle *Daily Leader*, the 36,647 voters on the municipal roll will have the option of declaring whether they will or not support the Corporation scheme for the improvement of the tramway service. The Corporation does not appear to have made up its mind whether power for running by "electricity" should be included in the Bill.

Proposed Electric Railway.—A proposal is on foot to lay a light electric railway between Lowestoft and Yarmouth.

South Staffordshire Tramways.—The *Staffordshire Advertiser* says that the Mayor of Walsall has succeeded in effecting an arrangement between the Electric Construction Company and the South Staffordshire Tramways Company for the running of the electric tramways until March 27th.

The Proposed Kidderminster and Stourport Electric Tramway.—Messrs. Alfred Dickinson & Co, who are the engineers to the proposed Kidderminster and Stourport electric tramway, have prepared, for the information of Parliament, a detailed estimate of the cost of constructing this scheme. The aggregate expense of the undertaking, as set out in the deposited Bill, is estimated at £24,910 19s. 11d, of which amount £19,002 19s. 11d. represents the cost of the tramways, and £5,908 the cost of the road and bridge widenings, and the erection of a generating station. The details of these figures show that the cost of the tramways is made up of £15,772 19s. 3d., which represents the actual cost of constructing the lines, and £3,230 0s. 8d. the cost of the electrical equipment. The sum of £5,908 represents £2,240, the cost of the generating station, £300 for the acquisition of land for widening Stourport Road, £940 for fencing on Stourport Road, £400 for widening the existing cutting on Stourport Road, £302 10s. for widening the bridge over the river Stour or Back Brook in New Road, £390 10s. for widening Cullwall Bridge in New Road, £495 for widening the bridge over the river Stour or Back Brook adjoining the Canal Bridge in Stourport Road, and £660 for widening the bridge over the canal in Stourport Road. The estimates show that the total length of this tramway will be 4 miles 5 furlongs 0·70 chains, of which only 4 furlongs 1·71 chains will be constructed as a double line.

Waterloo and City Railway.—The King of the Belgians, one day last week, paid a visit to the Waterloo and City Railway, now in course of construction. He was received at the works at 10 a.m. by Mr. Galbraith and Mr. Greathead, with Mr. Hay, resident engineer. His Majesty descended the shaft in the River Thames, and was conveyed along the contractors' electric railway to the working faces at the City end of the undertaking, which have now reached a point in Queen Victoria Street, near St. Nicholas Church. The party then returned towards Waterloo, where the working forces in Stamford Street are approaching the Waterloo Road, and inspected the working of the air lock; the tunnels at this end of the line being driven under pressure. The King spent nearly an hour on the works and in examining the plans and sections, and made minute inquiries as to the details of construction and cost, expressing himself greatly pleased with the rapid and successful progress of the railway.

TELEGRAPH AND TELEPHONE NOTES.

Communication with Western Australia.—In the *Times* of 16th inst., was published a Reuter's telegram from Western Australia, dated Perth, January 11th, marked "delayed in transmission." From this we presume that the Western Australian landlines have again been interrupted for several days.

New Cables For Cuba.—We learn that the ss. *Silvertown* and *Buccaneer*, belonging to the Silvertown Telegraph Company, are now on their way home, after having successfully laid a series of cables along the South Coast of Cuba for the Spanish Government. In the present disturbed state of the island it reflects much credit on all engaged that this work should have been so well carried out. The time allowed was, we are informed, unusually scanty, and the operations had to be carried on under the protection of soldiers, provided for that purpose by the Captain General of Cuba.

Telegraphic Communication with Africa.—The Postal Telegraph authorities, on Monday, announced that the cables between Laurenco-Marques (Delagoa Bay) and Durban, on the East Coast, and St. Thomas and Loanda (Angola), on the West Coast, were interrupted, thus completely cutting off communication with South Africa. The delay which occurred in the receipt of a telegram by the War Office from Sir F. Scott at Coomassie, dated January 17th (1.20 p.m.), and which was only received at the War Office January 20th (10.37 a.m.), is attributed to the breaking of the wire between Cape Coast Castle and Accra, and also to the interruption of the expedition's own telegraph to Coomassie.

The Laurenco-Marques-Durban cable has since been repaired. According to advices from the Eastern and South African Company to the Berne Bureau during the interruption, telegrams for South Africa passed over the landlines from Laurenco-Marques, but suffered some delay. The broken cable from St. Thomé to Loanda is not yet repaired.

Telephone between London and Berlin.—Reuter's correspondent in Berlin states that in the course of the debate upon the Post Office estimates in the Reichstag on Monday, Dr. Stephan, the Postmaster-General, quoted statistics showing the vast extension which the German postal and telegraphic systems had undergone since 1870, and in the course of his speech said that it was intended to establish direct telephonic communication between London and Berlin.

The Islet of Trinidad.—According to a Buenos Ayres telegram on 20th inst., it is reported from Rio de Janeiro that Dr. De Carvalho, Brazilian Minister for Foreign Affairs, is preparing a note demanding the immediate restitution to Brazil of the Islet of Trinidad. It is added that failure to comply with this demand will probably be made a reason for breaking off diplomatic relations with Great Britain.

Telegraphs in Western Australia.—Work has just been completed on the erection of a second telegraph line between Coolgardie and Hannans.

The Pacific Cable Committee.—We learn that the Australian Colonies will be represented on this committee by Sir Saul Samuel and the Hon. Duncan Gillies, both of whom have, on previous occasions, shown much interest in the development of this necessary work. A humorous correspondent suggests that England should be represented on the committee by Sir John Pender and Mr. W. H. Preece!

The Pacific Cable Scheme.—A Reuter's despatch from Sydney, dated January 19th, states that an intercolonial conference of Postmasters-General concerning the appointment of Australasian representatives on the Pacific Cable Commission to be held in London, and for other matters, met here on Friday and Saturday last. The following resolutions were adopted, subject to the approval of the various Colonial Governments, and recommended to the Australian Commissioners:—

"1. That the Pacific cable should be constructed and owned jointly by the various Governments interested.

"2. That the landing places of such cable should be only upon territory belonging to or under the control of the British Empire.

"3. That the construction, working, and maintenance be borne by Great Britain, the Dominion of Canada, and the contributing Australasian Colonies, in the proportion of one-third.

"4. That the route from Fiji to Australia be to Norfolk Island, and thence bifurcating to the nearest convenient landing places in North New Zealand and Moreton Bay respectively.

"5. That it is highly desirable that South Australia should join the other Colonies in the Pacific cable project, and, having regard to their vested interests in the trans-continental line, Dr. Cockburn be invited to move a proposition embodying the terms upon which the South Australian Government would be prepared to join the other Colonies."

Upon this Dr. Cockburn (South Australia) submitted the following offer:—"South Australia is willing to join in the project provided that a guarantee, either from the contributing Colonies, or jointly with the Imperial Government, be given that the financial position of South Australia as regards the Port Darwin line be maintained on the basis of the average for the last five years."

"6. That the Colonies joining should contribute equally to the undertaking.

"That in consideration of South Australia joining with the other contributing Colonies in the project, they would be willing, jointly with Great Britain, to guarantee that Colony against a further loss in connection with their trans-continental line in consequence of the construction of the cable.

"8. That Sir Saul Samuel and Mr. Duncan Gillies should be nominated as representatives of the Australasian Colonies on the Commission in connection with the Pacific cable, and that they should be requested to consult on all important points with the Agents-General of the Australasian Colonies."

A *Times* despatch on the same date from Melbourne, says that Mr. Reeves and Dr. Cockburn strongly protested at Sydney against equal payments by the Colonies for the cost of the maintenance of the Pacific cable. They declined voting on the question, and wished the payments to be on the basis of population.

West India and Panama Telegraph Company.—The receipts for the fortnight ended January 15th were £2,516, against £1,970.

CONTRACTS OPEN AND CLOSED.

OPEN.

Austria.—March 1st. The Municipal Authorities of Brünn are inviting tenders for the establishment of a central station in the town for the generation and supply of electrical energy for lighting and power purposes, including that necessary for an electric tramway. Tenders to be sent to the Burgermeisteramt der Landeshauprstadt, Brünn, Austria.

Canary Islands.—February 29th. Tenders are being invited for the 35 years' concession for the electric lighting of Sainte Croix de Teneriffe, Canary Islands. Tenders to be directed to the Ministère de la Gobernacion in Madrid, Spain.

France.—January 30th. Tenders are being invited by the General Direction of the French Posts and Telegraphs for the supply of 100 kilometres of electric submarine cable. Tenders to be addressed to the Direction Générale des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

France.—January 30th. The General Direction of the French Posts and Telegraphs is inviting tenders for the supply of 53,230 impregnated telegraph poles in eight lots. Tenders to the Direction Générale des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

France.—February 13th. The General Direction of the French Posts and Telegraphs is inviting tenders for the supply of 500 tons of galvanised iron telegraph wire in five lots. Tenders to be directed to the Direction Générale des Postes et des Telegraphes, Rue de Grenelle, 103, Paris.

Germany.—January 29th. Tenders are being invited by the Kattowitz Direction of the Prussian State Railways for the supply of a quantity of arc lamp carbons required for electric lighting purposes on the Kattowitz section of the State Railways. Tenders to be sent to the Königliche Eisenbahn Direction, Kattowitz, Germany.

Huddersfield.—January 29th. Persons desirous of tendering for the electric lighting and other works required to be done at Zion Methodist New Connexion Chapel, Lindley, Huddersfield, may see the drawings and specifications at the offices of the architects, Messrs. John Kirk & Sons, Huddersfield.

Italy.—February 28th. Tenders are being invited by the Municipal Authorities of Parma, an important old town about 60 miles from Milan, for the concession for the electric lighting of the public streets for a period of 15 years, commencing June, 1897.

Ramsgate.—The Ramsgate Marina Pier and Lift Company are inviting tenders for lighting the Promenade Pier, the Marina Restaurant, and the Palace of Varieties by electricity. Particulars from the Secretary at 23, Martin's Lane, Cannon Street, London, E.C.

Stanton.—January 27th. The Swadlincote District Council invite tenders for work connected with the proposed electric lighting of the town. Particulars from Mr. R. Cartwright, surveyor, Swadlincote.

CLOSED.

Chelsea, S.W.—The contract for wiring and fitting the Chelsea Infirmary for electric lighting, for the Guardians, has been secured by Messrs. Graham & Biddle, the total being £338 odd.

Colchester.—The War Office has placed the contract for the internal wiring and fittings, for electrically lighting the new military hospital at Colchester, with Messrs. Paterson & Cooper.

Germany.—The lowest tender submitted to the Posen Direction of the Prussian State Railways for the supply of 90,000 arc lamp carbons, was that of the Kalk Arc Lamp Carbon Works, of Kalk, Cologne. Ten other German firms competed for the contract.

NOTES.

Explosions — Gas v. Electric. — Gas explosions are so numerous, that were we to chronicle them all, we should need to set apart a column specially. When there were a few electric main box covers blown off about a year ago, the matter was taken very seriously by the newspaper press; but one cannot help observing that gas explosions are, as a rule, consigned to an insignificant corner paragraph. The following account of recent gas explosions in the City, taken from a daily contemporary, is convincing proof that there is more danger in our streets from the gas service than from the electric supply mains:—

A loud explosion occurred from the gas mains running through Lime Street, near Fenchurch Street, at noon yesterday (Tuesday). Scores of junior clerks were hurrying to their lunches, and not a few of them tumbled over from the shock. The windows of the offices occupied by the Messrs. Hubbard, oil and colour merchants, at 24, Lime Street, were shattered, and for a few minutes excitement in the immediate neighbourhood prevailed. Two weeks ago an explosion of a like nature occurred at the same spot, which tore up the roadway from opposite 24, Lime Street, to the corner of Fenchurch Street, and it was whilst repairing the damage done on that occasion that the second explosion occurred. It appears, from inquiries made on the spot, that a workman, while engaged in connecting the severed gas mains, suddenly became exhausted from the escaping fumes, and during the time he was being cared for outside the hole, the explosion occurred. Beyond the temporary excitement in the immediate neighbourhood caused by the incident, nothing of serious import occurred. It will take some time, however, to repair the roadway, which is badly torn up.

The Denayrousse Gas Burner in Paris.—For some months past the Denayrousse gas burner has created a great sensation in Paris. It consists of an ordinary burner combined with a ventilator of very low power, worked by an electromotor with the help of an accumulator, or a supply from some distribution. This ventilator draws up the outer air and sends it out under pressure into the flame. The results obtained are very interesting, the consumption falling to 10 litres of gas per carcel hour, but only with powers of 30 and 40 carcels. It will remain to be seen how this burner, which from its luminous power can only be used for lighting large spaces will act in practice, and what will be the cost of maintenance. It is said that the city of Paris is about to perform some experiments with regard to this subject.

Photographing the Unseen.—With reference to the new photographic process discovered by Prof. Röntgen, to which we refer elsewhere, the *Daily News* Berlin correspondent has attended some very interesting experiments in the "Urania." Dr. Spiess, the experimentalist of the "Urania" (a scientific institution), has succeeded in producing even better prints than those of the discoverer. In the course of his demonstration Dr. Spiess took a purse, put a key and some coins into it, wrapped the whole in black paper and laid it on a photographic plate. In order to show the great penetrating power of the rays he laid on the top of the wrapped-up purse a board two fingers in thickness. He then exposed the whole of the rays electrically produced in the Röntgen tubes. The plate was taken out after about 15 minutes, developed, and thrown on to a white curtain, when the key and coins were seen with the greatest clearness, the outlines of the purse being scarcely seen. The lecturer also showed a number of other experiments. Demonstrations of the process were also made in Paris, Vienna, and before the Royal Photographic Society in London on Tuesday evening. It has been found that the metallic objects exposed to Röntgen's rays have shown in the photographic reproduction all the inequalities that exist in the structure of metals, such as fractures, cavities, and so forth. In this direction the new photography would be of immense service to the engineering professions.

Waterfalls and Aluminium Works.—According to a Reuter dispatch from Christiania, the estate of Hafslund, near the great waterfall known as the Sarpsfos, between Christiania and Göteborg, has been acquired by a syndicate, chiefly consisting of German and American capitalists, for the sum of 800,000 kroner. The purchasers intend to form a large company, with a capital of 3,000,000 to 5,000,000 kroner, in order to utilise the water-power of the Falls for electrical force, and establishing aluminium works on the same principle as those now being constructed at the Falls of Foyers, in Scotland. The Sarpsfos is one of the finest falls in South-Eastern Norway, being 74 feet in height, and 116 feet in width. The water-power is already utilised, however, by numerous saw mills and cellulose factories, and the railway crosses the Fall, so that the proposed new works will probably not interfere to any great extent with the artistic aspect of the place.

The Cheltenham Fatality.—On Wednesday, last week, Major Cardew, on behalf of the Board of Trade, held an inquiry into the circumstances attending the death of John Pugh, an employé in the electrical department of the Cheltenham Corporation. We referred to the sad occurrence at the time, and it will be remembered that deceased succumbed to shock received in one of the sub-stations. Evidence was given by the electrical engineer, the surgeon, and others, Alderman Norman stating that they were making enquiries with a view to seeing what could be done for the relatives of the deceased. Major Cardew's report will be issued in due course.

Some dividends for 1895.—There is satisfactory evidence that both in electric railways and electric lighting companies fair progress is being made. The following are some of the dividends for the past and previous years :—

	1893. Per cent.	1894. Per cent.	1895. Per cent.
Westminster Electric Supply (ord.)	4	5	7
St. James and Pall Mall (ord.) ...	4½	6½	7¼
Liverpool Overhead Railway (ord.)	1	1½	3½

Gas.—We hear on excellent authority that two well-known London business houses have abandoned electric lighting for incandescent gas burners. Meanwhile Capt. Simmonds, the chief officer of the Metropolitan Fire Brigade, states that, of the lives lost during 1895, three were due to escaping gas, and one to curtains coming in contact with a gas burner.

Small Lamps for Inspection Purposes.—The ticket collecting staff at the Vauxhall Station of the London and South-Western Railway, have been supplied with small electric lamps, the current being supplied from a miniature battery carried in the breast pocket. The experiment is to be tried for a month.

Capital v. Labour.—On Tuesday afternoon, between 5 and 6 o'clock, a youthful member of the Silvertown Engineering staff was walking from South Tottenham to Lea bridge. The budding girdler of the earth is tall and slim, but athletic and well set up; and he wore a watch. In the dusk of the twilight an honest British workman (?) of the moleskin unmentionables type stopped him, and, in a tone of voice which unmistakeably denoted that he did not wish for any back answers, said :—"I want your watch!" "Do you?" mildly replied the India-Rubber Company's representative. "Yes," replied the honest son of toil, "and as I and my wife and three children are starving I mean to have it," "I can't help that, so you will have to fight for it," gallantly retorted the young engineer. "That's good enough for me," said Moleskin, "here goes." The burly ruffian made a mighty swipe, which the youngster easily dodged, and landing his opponent on the mark, which, in sporting phraseology, means the side of the jaw, laid him low. He rose again and rushed at the youth, only to be met with a straight left-hander between the eyes which floored him a second time and caused the ruby to flow freely. As the well-fed broad-shouldered vagabond did not attempt to get on his feet, Mr. Junior Engineer asked him if he had had enough, whereupon came the extraordinary rejoinder "You are no gentleman to hit a man shorter than yourself." At this unexpected termination to the fray the young man walked sadly from the scene of battle, leaving his antagonist sitting in the road more than ever puzzled over the vexed question of capital *v.* labour.

Lectures on Transformers.—Dr. Fleming commenced last Monday night, at the Society of Arts, a series of Cantor lectures on the alternate current transformer. The first lecture was distinctly interesting, because it was, to a great extent, based on some new and exhaustive experiments made at Bankside by some of Dr. Fleming's students. It was an evening of diagrams, and very instructive many of them were. Naturally a good deal was said concerning alternating current dynamos, and some very curious E.M.F. curves were shown on the screen. The lecturer made a good hit when he said at the commencement of his lecture that there had been three kinds of transformers, the mathematician's transformer, the contractor's or manufacturer's transformer, which had a high efficiency, and, thirdly, there was the real or practical transformer, with all its virtues and vices.

"Autocars."—Though it must not be propelled along the common thoroughfares at present, the horseless carriage is to have several opportunities shortly of disporting itself before the eyes of the public. Last week we announced a great international exhibition of motor carriages to be held in London by the Imperial Institute Authorities, and now we learn that the Crystal Palace directors have decided to hold, during May and June this year, an exhibition of carriages and every description of vehicle, from the historical stage and state coach to the latest development of "autocar," or horseless carriage, the latter being placed in motion in the grounds. Before the Civil and Mechanical Engineers Society last week Mr. F. R. Simms, C.E., read a paper on "Mechanical locomotion on common roads."

Death from Electric Shock at Hampstead.—For some weeks past, as we have already notified, Messrs. Siemens Bros. and Co. have taken charge of the public arc lighting, for the purpose of making an exhaustive trial. One of the firm's men, named Edward Clarkson, was engaged at the works on Tuesday evening. He was stooping to pick up a purse he had dropped, when he came into contact with the wires, and received the full current from one of the dynamos. He fell to the ground, and although artificial respiration was resorted to, he died almost immediately.

Shadow Photography.—There is a wonderful difference between the shadow photographs obtained by Prof. Röntgen and those of Mr. Campbell Swinton, as exemplified in this week's issue of *Nature*. In the former case the bones of the hand are shown without the slightest vestige of the flesh, while Mr. Campbell Swinton's do not get rid of the shadow caused by the flesh, which is clearly shown in our article on another page.

Amateur Diplomacy.—The United States Committee on Foreign Relations (doubtless after the most impartial consideration) have reported favourably on their own resolution enunciating the Monroe doctrine. In this resolution is pointed out, amongst other things, the objection taken to any attempt by any European Power to take or acquire any new territory on the American continents, or any islands adjacent thereto, for any right of sovereignty or dominion in the same, in any case or instance as to which the United States shall deem such an attempt to be dangerous to its peace or safety, by or through force, purchase, cession, occupation, pledge, colonisation, protectorate. We also read a telegram from Rio de Janeiro, stating that Dr. de Carvalho, Brazilian Minister for Foreign Affairs, is preparing a Note demanding the immediate restitution to Brazil of the islet of Trinidad. It is added that failure to comply with this demand will probably be made a reason for breaking off diplomatic relations with Great Britain. Thus we have all the material at hand for another pretty international difficulty, the origin of which is distinctly traceable to the dispute between the Brazilian Submarine Telegraph Company and the Brazilian Government Telegraph Department. As to the validity of the Brazilian claim to the Islet of Trinidad we express no opinion, but it is certain that whatever the justice of this claim may be, the matter of ownership could have been easily dealt with by Her Majesty's Government when necessary, had the Brazilian Government not been much irritated (as may be gathered from the report of the Brazilian Director-General of Telegraphs) by Sir John Pender's company. It is lamentable that at such a time the serious troubles which H.M. Government has to face should be still further increased.

Electrical Engineer Wanted.—Applications are being invited for the office of electrical engineer to the Corporation of Plymouth. The salary is £300, rising to £400. The engineer engaged is to design and supervise the construction of the electric lighting dust destructor and traction plant. Applications to be lodged with the Town Clerk, Municipal Buildings, by February 14th.

Society of Arts.—On Monday next, January 27th, at 8 p.m., the second Cantor lecture on "Alternate current transformers," will be delivered by Dr. J. A. Fleming, F.R.S. On the following Wednesday a lecture on "Standards of light" will be given by W. J. Dibdin, F.C.S.

The Coventry Electric Tramways.—We omitted to mention in our description of these tramways that Mr. H. Lavington Fletcher was the resident engineer during the construction of the line. The Bedworth section of the line was inspected by the Board of Trade officials last Thursday.

Appointment.—We learn that Lord Rayleigh has been appointed scientific adviser to the Trinity House. Since the resignation of Dr. Tyndall, the appointment, which was at one time held by Faraday, had been in abeyance. It has now been revived.

CITY NOTES.

Direct United States Cable Company, Limited.

THE ordinary general meeting was held on Tuesday, at Winchester House, Sir John Pender, M.P., presiding.

In moving the adoption of the report, the Chairman stated that the revenue for the six months ending the 31st ult., forming the first half of the company's current financial year, amounted, after deducting outpayments, to £43,938. The working and other expenses, including income-tax, but excluding the cost of cable repairs, absorbed £19,058, leaving £24,880 as the net profit for the half-year, making, with the amount brought forward, a total of £26,290, out of which two interim dividends of 2s. each per share had been declared, and £10,000 had been transferred to the reserve fund, leaving £4,148 to be carried forward. The revenue, which had commenced to improve in the early part of last year, had still further progressed within the last six months, for which period it showed an increase of £5,596, or more than 14 per cent. as compared with that of the corresponding period of 1894. Nevertheless, their aggregate ordinary expenditure had been only £34 greater. The cost of repairs to cables had been heavier than usual, having amounted to £6,984, which had been charged against the reserve fund account as usual. On the other hand, the fund had been credited with £4,619 for interest on the investments, and with £10,000 from the revenue account, bringing the balance of the reserve fund up to £306,000. The investments had been increased during the half-year by £16,400, and their present market value was about £55,000 more than they cost the company. They were reaching a period when their cable would be 25 years old, and although they had put in a great many repairs during the last two or three years, still, if the necessity suddenly arose to lay a new cable they would be short of the amount required for the purpose. The past six months had been rather an exciting period, and a great many things had been going on in America which had caused some anxiety. He still, however, thought that common sense would prevail, and that a settlement of the question which was now being agitated in America would thus be arranged. He had received four letters from different shareholders, who complained of the rate of dividend, and desired to see it increased. He should be only too glad to recommend the payment of a higher dividend, and if things went on as well as at present, he hoped they would be able to do so next time.

Mr. E. M. UNDERDOWN, Q.C., seconded the motion.

A brief discussion followed, and, in answer to questions, the CHAIRMAN stated that they had adopted Muirhead's and Taylor's recorder, and he was quite satisfied, having consulted Lord Kelvin and their own scientific men on the matter, that the company possessed a very valuable recorder. When the duplex was working they did not require the same amount of speed as when it was not in operation, but when the duplex was not working the automatic transmitter gave them about 40 per cent. of additional speed, which was very important. Everything was uncertain with America at the present time, and if the company had to cease working, their revenue would be affected. It was better not to begin to pay a higher dividend until the way was clear. Their traffic at the present time was 17 per cent. in excess of that at the same period last year. Cables had lately been established which affected them, the additional lines being in excess of the requirements of the Atlantic traffic. The advice which had been given to them to sell their Consols was not, he thought, bad advice. He believed they had cost the company about 96, so that their realisation would give them a good profit. As to the injury which might be done to submarine cables in the event of war, he once endeavoured to get the Government to make an agreement by which the lines would be protected, but the reply he received was that the Government would agree to it at once, only the General who would be in command would break it. That was what they all feared. He, however, did not believe that cables would be deliberately broken if it could be helped, although they might be interrupted.

Mr. JOHN NEWTON said he believed that the destruction on railways in time of war would be far more disastrous than any damage which could be done to cables. Cables could be stopped working by one effective cut, which could be easily repaired afterwards. He had never had the slightest apprehension that war would interfere with cable property beyond stopping the revenue for the time being of any particular cable.

The CHAIRMAN said that he was very much disposed to take the same view.

The motion was unanimously adopted.

Eastern Telegraph Company, Limited.

THE report of the directors, presented at the meeting held yesterday at Winchester House, E.C., for the half-year ended September 30th last, states that the revenue for the period amounted to £409,779, from which are deducted £96,703 for the ordinary expenses, and £47,165 for expenditure relating to repairs and renewals of cables, &c., during the half-year. After providing £3,423 for depreciation of spare cable, £821 due to revaluation of currency assets, and £5,748 for income-tax, there remains a balance of £255,917, to which is added £1,252 brought from the preceding half-year, making a total available balance of £257,169. From this balance there have been paid interest on debentures and debenture stock, dividend on preference shares, and two interim dividends of 2s. 6d. per share each on the ordinary shares, and after carrying £10,000 to the reserve fund for maintenance of ships, and £50,000 to the general reserve fund, there remains a balance of £49,352, which is carried forward to the next account. The revenue includes £25,447, dividends for the half-year upon the company's shares in the Eastern and South African, the Black Sea, the Direct Spanish, and the African Direct Telegraph Companies.

At the half-yearly meeting of this company, held yesterday at Winchester House, the MARQUIS of TWEEDDALE, who presided in the absence of Sir John Pender through indisposition, said the half-year was the best the company had ever experienced. The reserve for the period showed an increase of £47,223. Message receipts showed a satisfactory increase in all classes of traffic; the principal increase, however, was in Western Australia and South Africa. The total expenses showed a decrease of £829. The staff had increased by 20. An increase in expenses must be contemplated. Repairs and renewals of cables showed an increase of £3,456. Regarding ships,

the greatest economy was achieved in keeping them in a state of highest efficiency. He thought the repair of the Eastern and South African Company's cable between Aden and Zanzibar offered satisfactory evidence of the efficiency of this company's repairing service. The cable steamer, *Great Northern* was ordered to Zanzibar with instructions to call at various ports *en route* for repairing cables if trouble occurred. The following day a breach occurred 20 miles from the ship, which proceeded immediately to the spot and promptly repaired the cable, the traffic meanwhile passing over the land lines. Depreciation of spare cable showed a decrease of £1,392. After referring to the necessity for having a good reserve, the Chairman made a further statement with reference to the recent interruptions of the East and West Coast of Africa. No complaint had been received from our own or any foreign Government regarding the way the service was conducted; on the other hand, he believed our own Government was highly satisfied.

LORD SACKVILLE A. CECIL seconded the motion, and, after discussion, it was carried unanimously.

In the course of the discussion, CAPN. GOODSALL asked the chairman why printed reports of the meetings were not sent out to the shareholders as formerly. He knew the reports appeared in the company's paper, the *Electrician*, but it would be much better to have a special report sent round.

The CHAIRMAN replied that it was stopped because of the expense.

The retiring directors and auditors were re-elected, and the usual vote of thanks closed the meeting.

City and South London Railway Company, Limited.

THE report of the directors for the half-year ending December 31st, 1895, to be submitted to the half-yearly ordinary general meeting of the company, to be held at Winchester House, Old Broad Street, in the City of London, on Tuesday, January 28th, 1896, at 12 o'clock noon, states that the receipts from all sources for the past half-year have amounted to £24,554 9s. 2d., and the cost of working has been £14,638 16s. 4d., leaving a profit of £9,915 12s. 10d. Inclusive of the balance brought forward from December 31st last, the net revenue account shows an aggregate total of £10,922 7s. 4d. After making provision for the debenture and debenture stock interest, a balance remains available for dividend of £7,111 7s. 1d. Out of this sum your directors recommend that the full dividend of 5 per cent. per annum be paid on the preference shares, and that a dividend at the rate of 1¼ per cent. per annum be paid upon the consolidated ordinary stock, leaving a balance of £1,219 16s. 1d. to be carried forward to the next account. The following table shows the number of passengers, exclusive of season ticket holders, carried since the opening of the railway in each half-year:—

Half-year ended	Number of passengers (exclusive of season ticket holders).	Receipts (including season tickets).		
		£	s.	d.
December 31st, 1890 (11 days)...	165,000	1,568	3	9
June 30th, 1891	2,412,343	19,403	6	9
December 31st, 1891	2,749,055	19,798	16	6
June 30th, 1892	2,813,162	20,931	4	2
December 31st, 1892	3,117,602	22,002	17	5
June 30th, 1893	3,146,656	22,458	6	9
December 31st, 1893	3,093,351	22,067	14	10
June 30th, 1894	3,383,154	23,564	10	6
December 31st, 1894	3,275,649	23,540	12	4
June 30th, 1895	3,113,199	23,711	5	8
December 31st, 1895	3,172,438	23,780	3	7
Total since opening of the line	30,441,609	£222,827	2	3

During the summer quarter of the past half-year the traffic of the line was considerably diminished by the unusual and prolonged heat which then prevailed, and since that time the traffic of the line has suffered from the entire closing of the Oval for football matches, but notwithstanding these drawbacks there is an increase in the receipts, and this is especially noticeable in the item of season tickets, which indicates the steadily growing confidence of the public in the convenience, safety and punctuality of the line. In regard to the extension of the line to Finsbury Pavement, your directors have the pleasure to state that most satisfactory arrangements have now been entered into in respect to the more important properties required, and are such as justify them in fully believing that the proposed extension can be carried out within the estimate named in their report of January 22nd last, approved by the shareholders at the half-yearly meeting on February 1st following. Preparations are, therefore, being made for carrying out the extension without delay, and the proprietors will be asked at the extraordinary general meeting called for that purpose, out of the capital of the Act, 1893, to be then created, to sanction the issue of 20,000 5 per cent. preference shares of £10 each, which it is estimated will be sufficient to provide the amount required. It is intended that in the issue of these shares, arrangements shall be made that no charge will fall upon revenue in respect to the dividend upon them, until after the time at which it is estimated the extension will be open for traffic, and earning a larger sum than will be required for that purpose. The alterations at King William Street Station, to which reference was made at the last meeting, have occupied a longer time than was expected, owing to the necessity of avoiding interference with the existing traffic; but they are now completed, and will be brought into use in the course of a few days. The difficulty of dealing with the morning and evening traffic still continues, involving a considerable loss of revenue, but it is hoped that the additional trains which these alterations will accommodate will enable the press of traffic at those times to be better provided for. The additional sidings at Stockwell, referred to in the last report, are now finished, and will add greatly to the convenience of the working of that station. In view of the increased number of trains to be run, seven additional carriages have been ordered, and an additional locomotive built in the company's own shops, is nearly completed. The generating plant, which is in good working order and repair, has been materially strengthened by the erection of a small engine and dynamo, which will effect a decided economy in working the traffic in the less busy part of the day. An order has also been given for the erection of a condensing apparatus at the generating station, which it is anticipated will make a considerable reduction in the quantity of coal consumed. During the past six months a further sum of £9,400 terminable mortgage debenture bonds has been paid off. As the powers of the company for the compulsory purchase of lands in connection with the Act of 1893 will expire in August next, application is being made to Parliament for a further extension of that time. In the same Bill powers are sought for the acquisition of a site for a temporary shaft in the High Street, Borough, with the view of saving expense in the construction of the junction of the new extension with the existing tunnels. This Bill will be submitted to you at the special general meeting, of which notice has been given. The engineer of the company, Mr. Basil Mott, having resigned his position in order to take up an appointment in connection with the construction of the Central London Railway, Mr. P. V. McMahon, who has acted for some years as assistant engineer, has been appointed to succeed him. The directors retiring by rotation are Messrs. Charles Seymour Grenfell and Edwin Tate, who are eligible, and offer themselves for re-election. Mr. James Loriner Oliver is the auditor to retire on this occasion, and is eligible for re-election.

The City of London Electric Lighting Company, Limited.—Mr. J. Cecil Bull furnishes the following returns:—Revenue return, quarter ended December 31st, 1895:—Gross revenue from sale of current for public lighting, quarter ended December 31st, 1895, £3,107; corresponding quarter last year, £3,181; gross revenue from sale of current for private lighting, &c., quarter ended December 31st, 1895, £40,757; corresponding quarter last year, £26,052; gross revenue from other sources (estimated), quarter ended December 31st, 1895, £750; corresponding quarter last year, £404; total, quarter ended December 31st, 1895, £44,614; corresponding quarter last year, £29,637; increase, £14,977; equivalent of 8 C.P. lamps connected on December 31st, 1895, 195,317; increase during quarter, 24,490; equivalent of 8 C.P. lamps connected on December 26th, 1894, 135,460; increase during corresponding quarter last year, 21,429.

Liverpool Overhead Railway Company, Limited.—The report for the past half-year ending December 31st states that the accounts show an available balance of £11,499. The directors have resolved to recommend the payment of a dividend of 5 per cent. per annum on the preference, and 3½ per cent. per annum on the ordinary shares. For the corresponding period of 1894 the distribution on the ordinary shares was at the rate of 2 per cent. The balance carried forward is £2,074, against £1,087.

The Eastern and South African Company, Limited. This company announces the payment by warrants on February 1st next of interest for the half-year ended January 31st on its 4 per cent. mortgage debentures. The transfer books will be closed from January 28th to February 1st, both days inclusive.

The Eastern Telegraph Company, Limited.—This company notifies that the coupons on its 5 per cent. debentures due February 1st next will be paid on and after that date, at the banking house of Messrs. Glyn, Mills, Currie & Co., 67, Lombard Street, E.C. Coupons should be left at the bank three clear days for examination.

Westminster Electric Supply Corporation, Limited.—The directors of the above corporation have decided to recommend that a dividend at the rate of 9 per cent. should be paid for the past half-year, making, with the interim dividend already paid, a dividend of 7 per cent. for the year.

St. James's and Pall Mall Electric Light Company, Limited.—Directors of St. James's and Pall Mall Electric Light Company, Limited, recommend a dividend at the rate of 10½ per cent. per annum on ordinary shares for the half-year ending December 31st, making, with the interim dividend, 7½ per cent. for the year 1895.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending January 19th, 1896, were £1,004; week ending January 20th, 1895, £996; increase, £8; total receipts for half-year, 1896, £3,041; corresponding period, 1895, £3,001; increase, £40.

The Liverpool Overhead Railway Company. The receipts for the week ending January 19th, 1896, amounted to £1,172; corresponding week last year, £900; increase, £272.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending January 17th, 1896, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,915.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation Jan. 15th.	Closing Quotation, Jan. 21st.	Business done during week ended Jan. 21st, 1896. Highest.	Lowest
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 11s.	£2 2s.	...	44 — 46	45 — 47	45	...
2,993,560£	Do. do. 6 % Pref.	Stock	£5 2s.	£4 4s.	...	83 — 85	85½ — 86½	86¼	85
2,993,560£	Do. do. Defd.	Stock	...	...	...	6 — 6¼	6⅛ — 6⅜	6⅜	6⅛
130,000	Brazilian Submarine Teleg., Ltd.	10	6½% §	...	...	13 — 13½	13 — 13½	13½	13 3/16
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	...	...	110 —114	110 —114	...	..
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	... §	2½%	...	3¼ — 3⅜	3¼ — 3⅜	...	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	160 —170	160 —170	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	2 % §	1½%	...	1/16 — 1/8	1/16 — 1/8	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	12½ — 13½	12½ — 13½	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	...	20½ — 21½	20½ — 21½	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	3½ — 4½	3½ — 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 10½	10 — 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	...	4½%	...	102 —105% xd	102 —105 %	...	...
60,710	Direct United States Cable, Ltd.	20	2⅜% §	2 %	...	8 — 8½	8 — 8½xd	8¼	8 1/16
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½%	...	16½ — 16⅝	16½ — 16⅝xd	16⅝	16⅜
70,000	Do. 6 % Cum. Pref.	10	6 % §	6 %	...	17½ — 18	17¾ — 18¼xd	18	17 3/16
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	107 —110	107 —110	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	126 —129	126 —129	129	127
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	17 — 17½	17 — 17½	17 9/16	17⅛
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	...	100 —104	100 —104	103½	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	...	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	127 —130	128 —131	129¼	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	100 —104	100 —104	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	101 —104	101 —104	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	107 —110	107 —110	108¼	107¼
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	...	112 —115%	112 —115 %	..	...
180,227	Globe Telegraph and Trust, Ltd.	10	4⅝% §	4½%	...	9½ — 10	9½ — 10xd	9 15/16	9¾
180,042	Do. do. 6 % Pref.	10	6 % §	6 %	...	16½ — 17	16½ — 17xd	16 15/16	16⅝
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	8⅜%	...	21¾ — 22¼	21¾ — 22¼	22 5/16	21⅞
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	46 — 49	46 — 49	48	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	...	106 —110	105 —109	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	...	...	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 % §	5 %	...	5⅜ — 6	6⅛ — 6⅜	6 1/16	5 11/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	16 — 18	16 — 18	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	15½ — 16½	15½ — 16⅝	16 11/16	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	...	6¼ — 6⅜	6⅜ — 6⅝	6½	...
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	...	104 —107	104 —107	106	105
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	...	4¼%	...	9/16 — 11/16	9/16 — 11/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	108 — 111xd	108 —111	...	...
11,839	Reuter's Ltd.	8	0 %	*nil*	...	4½ — 5½	4½ — 5½	5½	...
3,381	Submarine Cables Trust	Cert	...	...	...	127 —132	126 —131	129½	128
58,000	United River Plate Teleph., Ltd.	5	...	...	...	2½ — 3	2½ — 3	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	90 — 95 xd	90 — 95	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	...	*nil*	...	5½ — 6½	5½ — 6½	...	...
238,300£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	101 —104	101 —104	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1 — 2	1 — 2	...	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	...	...	94 — 99	94 — 99	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	2½%	3 %	...	9 — 9½	9 — 9½	...	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	6½ — 6⅝	6½ — 6⅝	...	...
33,129	Do. do. do. Def. Ord.	7½	...	1 %	...	2¾ — 3¼	2¾ — 3¼	...	...
165,200£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	...	103 —107	103 —107	...	...
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	...	103 —107	103 —107	...	...
88,321	West India and Panama Teleg., Ltd.	10	⅞%	½%	...	⅞ — 1⅛	⅞ — 1⅛	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	10¼ — 10⅜	10¼ — 10⅜	10⅜	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	8½ — 9½	8½ — 9½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	...	108 —111	108 —111	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	...	113 —118	113 —118	...	...
164,300£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	...	102 —105	102 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	4½%	...	5⅛ — 5⅜	5⅛ — 5⅜	5¼	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	...	6⅞ — 7¼	6⅞ — 7¼	...	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	...	...	115 —118	115 — 118	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	5 %	...	12⅜ — 13¼	12⅜ — 13¼	13¼	...
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	15½ — 16	15⅝ — 16¼	16	15 15/16
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	132 —136	133 —137	133½	...
22,475	County of London and Brush Prov. Elec. Ligtg., Ltd., Ord. 1—22,475	10	...	...	...	8 — 9	8 — 9	...	...
10,000	Do. do. do. 6% Pref., £8 pd., 40,001—50,000	10	...	...	...	10½ — 11	10½ — 11	...	...
50,000	†Liverpool Electric Supply, all paid	5	5 %	5½%	...	7⅞ — 8⅛	7⅞ — 8⅛	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	2½%	3 %	...	10¼ — 10⅜	10½ — 11½	11	10 9/16
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	...	...	114 —117	114 —117	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	1 %	...	8½ — 9	8½ — 9	...	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	4½%	6½%	7½%	8¼ — 8⅜	8½ — 9	...	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	...	9 — 9½	9 — 9½	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	4 %	5 %	7 %	8½ — 9	8⅝ — 9¼	9	8⅞

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1893.	1894.	1895.	Closing Quotation, Jan. 15th.	Closing Quotation, Jan. 21st.	Business done during week ended Jan. 21st, 188 Highest.	Lowest
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	3	6 % §	...	...	1 — 1¼	1 — 1¼	1	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	6 % §	...	...	1⅞ — 2	1⅝ — 1⅝	1⅞	1⅝
125,000£	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	112 —115	112 —115	112⅜	...
630,000£	City and South London Railway	Stock	1 1/16%	1⅛%	1 3/16%	40 — 42	40 — 42	41⅞	40⅝
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	...	...	2 — 2½	2 — 2½	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	...	5 %	...	1¼— 1⅜	1¼— 1⅜	...	...
17,139	Do. do. do. "A" Shares 01—017,139	5	...	...	...	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ...	Stock	...	4½%	...	104 —107 xd	104 —107	105	...
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	*nil*	...	⅝— ⅞	⅝— ⅞	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	...	2 — 2½	2 — 2⅜	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	¼— ½	¼— ½	...	...
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	⅜— ⅝	⅜— ⅝	...	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	...	...	¼— ⅜	¼— ⅜	...	...
9,600£	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	...	...	9½— 10½	9½— 10½	...	...
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	6 %	...	13½— 14½	13½— 14½	...	...
3,000	Do. do. do. 7% Pref.	10	...	...	...	15½— 16½	15½ — 16½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	...	...	108 —111	108 —111	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	10 %	...	19 — 20	20 — 21	20½	19⅛
200,000£	Do. do. do. 4½ % Deb., 1896	100	4½%	4½%	...	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	1 %	1½%	...	11½— 11⅞	11 15/16— 12 3/16	12	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	...	15½— 15⅝	15⅝— 16	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	20 %	...	41 — 43	43 — 45	44⅜	43½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	...	102 —105	102 —105 xd	...	...
54,000£	Waterloo and City Railway, Nos. 1 to 54,000, £4 paid ...	10	...	...	...	4⅜— 5	4⅜— 5	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last ividend paid was 50°/ for 189

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1893—0°/₀§; 1891—7°/₀§ 1890—8°/

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6¼.

Electric Construction Corporation, 6 % Debentures, 95—100xd.

House-to-House Company (£5 paid), 3⅜—4¼.

Do. do. 7 % Preference, of £5, 7⅜—8¼.

Do. do. 4½% Debentures of £100, 108—110.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 7⅜—8¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6⅜—7¼.

Liverpool Electric Supply, £5 (fully paid), 7⅜—8¼.

London Electric Supply Corporation, £5 Ordinary, ⅜—½.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 6⅜—7¼.

Bank rate of discount 2 per cent. (February 22nd, 1894).

A COMPENSATION METHOD FOR AFFORDING PROTECTION AGAINST THE WORKING EFFECTS OF ELECTRIC TRAMWAYS.*

BY DR. O. FROHLICH.

A FEW months ago I described in the *Elektrotechnische Zeitschrift* two proposed arrangements which were intended to protect electrical measuring instruments in a physical institute from the disturbances set up by the working of electric lines. The principle of compensation in both proposals, and the arrangement mentioned in the first, were essentially the same as mentioned by Mr. G. Kapp at the time; but the second device was different.

The principle of compensation, is that wires, in which either a part of the earth current or a branch current encircling the earth current at the same time, are so led above and around the instruments to be protected that the immediate effect of the earth current ceases. According to the first proposal the compensation wire, or the system of wires, terminated in earth plates which were buried near the house to be protected, and which took up a portion of the earth current. On the other hand, in the second arrangement, the compensation wire is laid in several branches to the rails in the neighbourhood of the Institute, carried over the house and connected with the ends of the rails in the power station.

The first proposal should compensate all the roving earth currents under or near the house; the second, only those earth currents proceeding from the electric line. The second arrangement possessed the advantage over the first in that the earth plates and the difficulties therewith connected were avoided, and, in the main, only metallic conductors, the rails and compensation wire, were employed. Without letting the first proposal fall to the ground, I considered it more appropriate to further work out the second arrangement.

I have succeeded in essentially realising the object in view and have eliminated, in the case of one electric tramway, from 75 to 80 per cent., in another 95 per cent., and in a small type, 98 per cent of the disturbances set up in an instrument. However, this was only rendered possible by altering and improving the second method, by means of which, in its present form, one is enabled to reduce the disturbances in an instrument through the operation of an electric tramway to a very small amount.

* Abstract of paper read on October 22nd before the Berlin Electrotechnical Society.

At first, experiments were made by Dr. Rasehorn on the electric tramways Steglitz—Lichterfeld and Dresden—Blasewitz, partly in order to ascertain the extent and nature of the disturbances, but especially to test the compensation method in its original form. So far as compensation is concerned, the experiments yielded no practical results, but they showed the faults of that method, and convinced us of the necessity of not immediately dealing with the changes in the working of the electric tramway, but to systematically proceed to endeavour to compensate the disturbances set up by a single car on the journey over the whole track. There was little prospect of solving this problem with a line in operation, as the period of cessation of traffic was limited to a few hours in the night. A small experimental line was therefore constructed, and was so arranged that on the running of the car, perceptible disturbances arose in a magnetic needle, and these it was sought to compensate.

It was first of all necessary to ascertain from the operation of the line the curve of disturbance, that is to say, the course of the interruptions observed in the instrument when the model car travelled the full length of the line, and then to arrange the compensation curve, or the course which the current showed in the compensation wires during the running over the line, so that it is throughout equally opposed to the disturbance curve; then the interruptions for each position of the car were compensated.

As it has already many times been determined that the so-called vagabondising earth currents are the principal cause of disturbances, and the loop effect or the immediate distant effect of the electric railway conductor usually flows back opposed to the effect of the earth currents, the model line was arranged so that the loop effect almost entirely disappeared and the disturbance curve almost only represented the course of the effect of earth currents. The curve obtained showed that when the car starts from the power station a disturbance is first set up in the instrument. When the car approaches the instrument, the disturbance slowly increases and rapidly begins to augment when the car reaches the height of the instrument; this increase continues until the car has passed onwards leaving the instrument a certain distance behind, and then gradually changes to a constant maximum which lasts until the car has traversed the whole of the line.

This typical course of disturbance represents the case of a straight line of tramway with the needle in the same direction as the line, and is modified if the line curves and the needle have a different direction. The necessary modifications do not, however, appear to be important, at all events with a needle equally directed, since this course was observed on the Dresden—Blasewitz and the Pankow—Gesundbrunnen lines. The particular curve in question shows that the principal effect of the earth currents commences when the car has

passed the instrument, because the earth currents are mainly formed near those parts of the rails traversed by the current, although existing at some distance from the car, and, further, that the earth currents somewhat precede the car, or that an effect manifests itself before the car reaches the height of the instrument.

The disturbances caused by the loop effect show, however, quite another course to the vagabondising earth currents. Whilst the latter commence to substantially affect the instrument on the car passing by, and for a certain distance remain constant, the loop effect acts as an uncommonly powerful but short magnet which moves along the line behind the car, but at a speed of about half of the latter. The course of action of the magnet upon the instrument depends essentially upon the position of the instrument and the direction of the needle contained therein.

The loop effect acts in the same sense as that of the earth currents, since the latter have the same direction as the current passing through the rails. On placing the instrument nearer to the track the immediate magnetic effect of the car motor is noticeable.

As shown diagrammatically by the author, the current passing from the car returns to the generating station not only by the rails behind the car and the surrounding earth, but also partly by means of the rails in front of the car and the thereto connected earth. This is specially the case if the conductivity of the rails is bad, and the result is that the effect of the earth currents precedes the car, and, moreover, before the car reaches the instrument this effect can take the opposite direction to that which arises after the passage of the car. A curve taken from the Dresden—Blasewitz line shows at the beginning a negative variation which probably proceeds from the earth currents preceding the car.

It is possible that the foregoing account of the causes of the disturbances is not complete and that on further investigation they will be increased. In the meantime the main result is that in most cases the earth currents form the preponderating causes of the disturbances.

Let us now consider the course of the compensation current or curve. As this current has to obviate the disturbances the device must be so arranged that the compensation curve is as much as possible directly opposed in form and extent to that of the disturbance curve. The question arises as to whether this is attained by our old proposal, and if not, how the compensation method is to be modified.

The modifications introduced consist in the use of several compensating loops, capable of adjustment and connected with the rails, and not directly with the end of the rails at the power station. This arrangement has reduced the disturbances to a minimum.

In deciding upon a system of protection, there is the choice of two methods: The compensation of the whole building by coils carried round the structure, or, the compensation of the individual instruments by coil frames. Both systems are shortly to be tested on the Pankow tramway, but as far as can be seen at present the separate compensation of each instrument is to be preferred.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

At the ordinary general meeting held at the Institution of Civil Engineers, 25, Great George Street, on Thursday evening, January 16th, the retiring president (Mr. R. E. B. Crompton), after distributing the various premiums to the successful readers of papers, said his last duty was to vacate the chair in favour of a better man. He did not think the choice of the Institution could have fallen on a more worthy man than Dr. Hopkinson, to whom they all owed so much, and who had by his scientific work and by his practical contributions to their scientific knowledge of the dynamo, and by his careful studies of the properties of the materials that they used in the construction of electrical apparatus, had done more almost than any Englishman, or he might say more than any man in any country, to forward the great cause of electrical engineering. In conclusion, he could only say that he felt himself a proud man to be succeeded by such a great man.

Major-General Webber said it was his unexpected, but warmly appreciated duty, to ask the Institution and all their guests present that evening to agree with acclamation, "That the cordial thanks of the Institution are due to Mr. Crompton for the energy and ability he has displayed in performing the duties of president during the past year." Of his energy and his efficiency, those who had attended their meetings were fully aware, and, therefore, he would occupy none of their time in bringing home to them what they felt for themselves. But of his efficiency in the council chamber, and as chairman of their committees, they could have very little knowledge, except from previous acquaintance with the energy and zeal and ability he had given to all the work he had undertaken during the many years that they had had the honour and pleasure of knowing him, both as a friend and as a fellow engineer. To him (the speaker) this had been a red letter year, having sat as he had done under Mr. Crompton in committees, for their late president's activity, constant attendance, and intimate acquaintance with detail had brought about results which he was glad to say would last through the history of their Institution. As chairman of one committee in particular—one which came most readily to his mind—the committee for the revision of the fire risk rules, he showed a power of leadership, and a power of direction and guidance, which he (General Webber) had rarely seen exercised by any other chairman under whom he had sat.

Mr. Dane Sinclair seconded the resolution, which was carried with acclamation, and briefly responded to by Mr. Crompton.

The President, who was loudly cheered, having taken his place in the chair, said that, before delivering his address, he wished to say something with regard to a matter which intimately concerned the country. Recent events had made unpleasant revelations to many of them. They proved that among other peoples there were certain persons who would regard with satisfaction any danger that might befall us, and that the error of a few of our countrymen might be magnified by persons who did not like us, so as to involve us in quarrels with people we had always regarded as our friends. To provide against such danger was no Chauvinist or Jingo move. It threatened no one; it simply meant that they, as Englishmen, would not allow the evils that might result from the follies of their countrymen abroad to cause mischief at home. Continental nations met this and all other dangers by forcing military service on every able-bodied citizen. We hoped to attain the same object without compulsion. Surely it was the duty of every one of them to consider what they could personally contribute towards the nation's defence. And for such societies as theirs it was their duty to consider what action they could take in their corporate capacity to the same end. They had a number of past and present Royal Engineers on their roll. Electricity was put to innumerable uses in military operations at the present day; for the training and firing of guns and the firing of mines; for telegraphs, for signalling, for search lights. Their technical knowledge might be very useful indeed, and it could not be doubted that many of them would be glad to give their services. The question was how it could be done, and what steps should be taken to do it? He knew certainly for a fact that anything they could do effectively would be welcomed heartily by the highest authorities in the Army. He had consulted some of their best known members. He wrote to Lord Kelvin and asked him what he thought of the idea of utilising the qualifications of electrical engineers for purposes of national defence. Lord Kelvin cordially approved of it, and said he would be glad to do all he could to further the movement, from which he expected valuable results. Other distinguished electricians had agreed that such a movement would be eminently useful, and at the present moment would be likely to be successful. The council of the Institution had passed a resolution that steps should be taken to render valuable, for purposes of national defence, the technical skill of their members, and a committee had been formed to consider the question, constituted as follows: Dr. Hopkinson (president), Mr. Crompton, Mr. Henry Edmunds, Sir F. Abel, Mr. A. E. Mavor, and Mr. R. S. Erskine. Probably this committee would first of all ascertain what members were willing to serve, and what time they could give to training, and what places could be filled in existing corps. If they had more men than were necessary to fill these places a new corps might be formed. If each of them would do his duty according to his opportunities, they would succeed in rendering valuable service to their country.

The President then proceeded to deliver his inaugural address.

Inaugural Address, by Dr. John Hopkinson, M.A., F.R.S., President, delivered January 16th, 1896.

When it was suddenly proposed to me that I should a second time be your president, I felt considerable reluctance to accept the duty. This reluctance arose from two causes. Of the first I am ashamed—pure laziness—and of it the less I say the better. The second was a *bonâ fide* doubt as to whether I was specially suitable for the post. But it soon struck me that that was a matter for which those who proposed me were responsible, and not I who accepted, but had not sought the office. But, if I felt a temporary reluctance, do not suppose that I for a moment failed to appreciate the honour which had been done me. To be called by his fellow professional men to fill the chair which has been occupied by men of such distinction as Kelvin, Siemens, Abel, Crookes, not to mention others, is an honour of which anyone may confess himself proud. After once having occupied this chair, to be called to it a second time is a greater honour, for it shows that one's efforts, however imperfect, have been generously appreciated by those for whom they were made. I thank you for the honour, and assure you I will do my best to verify, if I can, the judgment of those who proposed and you who elected me, rather than my own misgivings.

The century which is now just drawing to a close has been a time remarkable, above all other times, for the extraordinary development of our knowledge of the physical sciences, and in particular of experimental physics and chemistry, and for the extent of the practical application of this knowledge to useful purposes. The century has seen the discovery of the mechanical nature of heat, of the spectroscope, and of the whole of the science of organic chemistry; it has seen the enormous development of the application of the steam engine, the construction of our railway system, and the supersession of sailing vessels by steamboats. But perhaps the most remarkable illustration of this development is to be found in the science, and its application, with which this Institution has to deal. Consider what was known of the sciences of electricity and magnetism at the end of the last century. The two sciences were then quite unconnected. In magnetism the properties of permanent magnets were known—that is to say, it was known that steel needles could be rendered magnetic by rubbing with a loadstone, and that when so rendered magnetic, they would tend to remain in that condition; it was known that if a magnet were broken in parts, that each part would exhibit north and south poles like the magnet from which it was broken. It was also known that the earth exhibited properties of magnetism, inasmuch as a magnetic needle, free to move, would point, on the

whole, to the north; broadly speaking, what we know to-day about permanent magnets was known, and that was about all. The practical applications were limited to the use of a magnetic needle in the mariner's compass. The knowledge of electricity was confined to what is now known as electrostatics. That certain bodies when rubbed exhibited peculiar properties, attracting and repelling each other, had long been observed, and the facts expressed by the hypothesis of positive and negative electricity were known, namely, that two pieces of amber which had been rubbed repelled each other, two pieces of glass which had been rubbed repelled each other, but a piece of rubbed glass and a piece of rubbed amber attracted each other. In a general way the properties of conductors, as distinguished from insulators, were also known in their relation to charges of frictional electricity. Cavendish had made elaborate investigations into the capacity of condensers, the condensers being usually of glass, and being charged by the old-fashioned frictional means. Franklin had proved the identity of the cause of lightning with the cause of the sparks produced by frictional electricity. Just 100 years ago Galvani had made his celebrated experiments, showing that the muscles of the limb of a frog were disturbed by contact with a piece of copper and a piece of zinc, which touched each other; and that was the only fact which, up to that time, had ever been observed in the enormous group of facts which now constitute our knowledge of the production of electricity by chemical action. Shortly stated, that was the extent of our theoretical and experimental knowledge of electricity. The practical applications of this knowledge were almost *nil*. I can recall nothing excepting the provision of lightning conductors as a protection to buildings.

It is worth insisting that the additions to our knowledge of the properties of permanent magnets and of frictional electricity during the century have not been of great importance, and the practical applications of these limited branches of knowledge have been few. If one is asked what uses can be made of our knowledge of frictional electricity apart from the phenomena of currents, it is hard to name anything of importance. In like manner, in regard to our knowledge of permanent magnets, it may almost be said that the advances in practical applications have been confined to improvements in the use of the mariner's compass, which, most important although they are, have had comparatively little share in the changes in our conditions which the last hundred years have witnessed. Almost everything in the way of practical applications of electrical science has been the outcome of subsequent discoveries—the voltaic cell, discovered by Volta in the year 1800; Davy's discoveries in electrolysis; Oersted's discovery of the action of currents upon magnets; Ampère's discoveries of the mechanical action of currents upon currents; and Faraday's discoveries in electro-magnetism; not to mention the names of eminent men still living. Now the remarkable thing is that none of these phenomena had ever been witnessed by mortal man. It was not that they were constantly occurring around us, and that the explanation had not been seen; it is the fact that the phenomena had never been experienced. It would seem that the phenomena of electric currents as Volta discovered them, do not occur in nature on any substantial scale. Electro-magnets may be regarded as purely a creation of the human mind; so far as we know at present, no example of an electro-magnet is found in the natural world. The great currents produced by the action of electro-magnets have so far as we know, no counterpart in nature—not only no counterpart in degree, but none in kind. In this respect our science differs much from many others. In mechanics and in heat we may find the phenomenon of which we make use occurring without our aid on an enormously greater scale than we are accustomed to use; changes are constantly occurring around us, and it is conceivable that we might have obtained much of our present knowledge by the aid of observation without experiments. But it is not so with electricity and magnetism. We should be puzzled even now to adequately illustrate the facts we know by observation alone without experiment.

Let us consider for a moment the practical applications which have been made of electrical knowledge during the last 60 years. The first, of course, is the telegraph. What are the scientific facts which have been used in the development of telegraphy? The currents are generated either by chemical means or electro-magnetic means. The receiving instruments either depend for their action on the action of currents upon magnets, or, in a limited number of cases, on electro-chemical decomposition. We might put it broadly thus—that, with the exception of the distinction between conductors and non-conductors and certain properties of condensers, the telegraph could do without anything that was known up to the end of the last century, and that it wholly depends upon more recent discoveries. Much the same may be said with regard to the more recent applications: the electric light, electric transmission of power, and the rapidly growing department of electro-chemistry may all be said to be quite independent of any facts which were known before the year 1800, and entirely based upon discoveries made since. Suppose it were a fact that electricity could not be produced by friction, that we knew nothing concerning the attraction which oppositely electrified bodies have for each other, that permanent magnets did not exist—or, in other words, that iron had no hysteresis—would it make any material difference, so far as we know, in the practical applications of electrical science to telegraphy, telephony, electric light, electric transmission of power, or electro-chemistry? The permanent magnets, which are practically used only in instruments, would be at once replaced by electro-magnets, and the apparatus would work just as it does now.

Enough has been said, I think, to show that the knowledge of electricity and magnetism which was possessed by men at the end of the last century, intensely interesting though it was, has not been the parent of the great applications of later days; that the knowledge of the last century has not grown in any great degree upon the lines which existed at its commencement, but that our advances in science, as in practice, were the result of the discoveries which were made since the beginning of the present century.

It has been a frequent practice with presidents of societies devoted to promoting some department of science, theoretic or applied, to deal with the history of the science in their presidential addresses—to show how one idea has led up to another, and how marked have been the advances made. This evening I propose to adopt a different course. What I wish to consider is, how would the theory of electricity have been arranged if the order of discovery of the facts of the science had been other than it has been? Here I owe you some words of apology. You are a practical body more immediately interested in the application of science to the service of man than in the promotion of abstract knowledge. The justification I would offer for my subject is that the science of electricity, whether viewed from the practical or theoretical side, is in a state of extraordinarily rapid advance. The rules of practice of yesterday are of little use to-day, hence more discussion is needed, more publication is needed, than in departments which are in a more stable state. Furthermore, there is no department of applied science in which the connection with theory is so close and intimate. The practical electrical engineer reads eagerly the results of those who, careless whether their work finds application or not, labour to advance knowledge; he attacks these results whether they be expressed in the ordinary speech of men or in mathematical symbols. On the other hand, much of our knowledge of electricity, viewed from the scientific side, has come from those who are concerned with practical application. Nowhere else do we find a closer interdependence of pure science and practice. In what I have to say there will be much that is trite and obvious to the merest tyro in electricity. What I wish to do is to show how the facts of electrostatics can be explained by the facts of current-electricity without hypothesis; and it is necessary to rehearse elementary principles. In a complicated subject like electricity, in which the appeals to our senses are indirect, there are open to us many ways of arranging our ideas, any one of which will give us a consistent account of that which we observe. We may take as our fundamental basis one or other of various groups of facts, and deduce others therefrom. The actual arrangement of ideas on the subject depends in a measure upon the accident of the historical order of discovery. Thus, the fact that actions at a distance between electrified bodies were known many years before the phenomena of current-electricity and electro-magnetism, is the reason why that part of the science which treats of such actions is to-day treated first and made the basis of the rest. The time has, I think, come when we may with advantage reconsider our position, and see whether or not our ideas may be more conveniently arranged. The arrangement which is most convenient may no doubt depend upon the phenomena which occupy the most prominent place in the practical use we wish to make of the science. Those facts are best treated as fundamental which are most frequently used, provided they are sufficiently simple. To the practical electrician, are the facts of current electricity, or of the attractions and repulsions of electrified bodies, more familiar? Surely the transference of energy by current is the agent by which almost every operation he purposes is effected, whilst the phenomena of electrostatics touch him only at points in the theory of electrometers, and so forth. I propose, then, this evening to sketch out very briefly, *ab initio*, how we may base the science of electrostatics upon the theory of current electricity, taken as fundamental. We might, if we pleased, drop the word "current" altogether, and substitute another. It seems hardly worth while, but I shall ask you to bear in mind that, if used to-night, it does not connote the idea of anything flowing along the conductor. It is a name for a directed magnitude, and nothing more. I shall have occasion to refer to some elementary experiments; but you will bear with me, I trust, for we are concerned with arranging the subject on as small a basis of facts as is consistent with rigid deduction. Please, then, to banish from your minds all theory on the subject, and let us imagine that the facts of current electricity are first discovered, and that it is only when these are well developed that electrostatic attractions and repulsions are found out.

In a vessel of dilute sulphuric acid is placed a piece of pure zinc, or of zinc carefully amalgamated, and also a piece of copper, platinum, silver, or carbon, the two plates not being in contact with each other. It is observed that no change takes place; the acid does not attack either plate. The two plates are now touched with the two ends of a wire of copper or other metal; immediately the zinc begins to dissolve in the sulphuric acid, and gas—which, if collected, proves to be hydrogen—is found on the copper or platinum plate. If the plates are large, and near together, and the wire is not too long or thick, it becomes very sensibly heated. On separating the wire from either plate, the chemical reaction and the heating of the wire cease. When the wire touches both plates, there is then development of chemical energy in the vessel of acid; but a part of this energy appears as heat, not where it is developed, but in the wire connecting the plates. Whether this energy goes across the space of air between the zinc plate and the wire, or whether it goes along the wire, we do not know; but that the two plates should be rendered continuous with each other by a wire, or some equivalent, is a condition precedent to the chemical reaction and to the heating of the wire.

Let two such vessels of dilute acid, with plates of zinc and copper, be provided, and let the copper in one vessel be connected metallically to the zinc in the other; nothing happens until the copper in the second vessel is connected to the zinc of the first; then both zincs are dissolved, hydrogen is liberated on both copper plates, and the connecting wires are more or less heated.

Again, varying the experiment, let the coppers in the two vessels be connected together and the zincs be connected together; no reaction or heating occurs.

The combination of a piece of zinc and a piece of copper dipping separately into a vessel of dilute acid is called a "galvanic cell," or element; a series of elements connected together, copper to zinc, is

called a "galvanic battery." Galvanic elements and batteries take a multitude of forms: the zinc may be replaced by another metal—for example, cadmium—and the copper by platinum; many other liquids than dilute sulphuric acid may be used; but all galvanic batteries have this in common—to cause them to work, the chain or circuit must be completed by a wire touching the zinc at one end of the series and the copper at the other, and then chemical reactions occur in the cells, and heat is liberated in the metal connections. The zinc and copper plates, or their equivalents, at the ends of a galvanic battery are called "poles."

Let two plates of platinum dip into dilute sulphuric acid; connect one plate by means of a wire to the zinc pole of a battery, the other plate to the copper pole. So soon as the connections are made, chemical reactions occur in the cells of the battery, the connecting wires are more or less heated, and, further, a reaction occurs in the vessel in which the platinum plates dip, the water is decomposed, gases are liberated on the two plates; if these are collected, it is found that the gas from the plate connected to the zinc pole is hydrogen, that from the plate connected to the copper is oxygen. The effects cease on detaching either wire from the platinum plate or the pole of the battery, or otherwise interrupting the continuity of the circuit. In this experiment is seen a chemical reaction liberating energy in the cells of the battery, and another chemical reaction absorbing energy in the vessel containing the platinum plates; how the energy passes from one vessel to the other we do not know.

The experiment may be varied. Let two plates of zinc or other metal dip into a solution of salt of zinc or other metal, and let the plates be connected to the poles of a galvanic battery for a time. If the plates be weighed before and after the operation, it is found that the plate which was connected to the zinc pole has gained in weight, and that the plate which has been connected to the copper has lost an equal amount. By weighing such plates, and noting the time the experiment was allowed to continue, it is practicable to examine quantitatively the phenomena of a galvanic circuit. Such pair of plates and solution of salt is called a "voltameter."

Suppose now a series of voltameters, having in each the same metal, are connected together in a chain, a plate of one to a plate of the next, and the two ends of the chain connected to the two poles of a battery, it is found that, no matter what be the size and form of the voltameters, their position, or the arrangement of the connecting wires, there is the same gain and loss of weight of the plates in all the voltameters; it is further found that, if the zincs of the cells of the battery are weighed before and after the experiment, and if the metal used in the voltameter be zinc, the quantity of zinc dissolved is the same in all the cells, and is the same as that transferred in each voltameter. The rate of dissolution and deposit is the same in the several voltameters and cells. In a closed galvanic circuit we have, then, a measurable something the same for all cross-sections of the circuit, measurable by the quantity of zinc or other selected metal which is transferred from one plate to the other of a voltameter in a unit of time. This something has direction as well as magnitude, and as the magnitude may be represented in terms of any unit chosen by a numerical quantity C, so the direction may be represented by the sign + or −. It is arbitrarily chosen to take as + the direction from the plate which loses weight to that which gains weight through the liquid in the voltameter. The quantity C taken, with its sign, is called the galvanic or electric current round the circuit, but it must not be supposed that it is known that there is anything flowing round the circuit.

Suppose that, instead of a simple galvanic circuit, the circuit divides or branches as indicated in the sketch, in which A, B, C, are voltameters, F, E, D, the battery. It is found that the quantity of zinc moved in B, together with the quantity of zinc moved in C, is equal to the quantity moved in A. This gives us the idea of current in the branch, B or C, and we may say that the current in A is the algebraic sum of the currents in B and C.

Not all bodies are competent to complete a galvanic circuit. Thus, if the copper wires which serve to connect the poles of the cells of the batteries and the voltameter are any of them replaced by thread, the phenomena of galvanism do not occur; if one of the wires be severed and a piece of paraffined paper interposed, the phenomena do not occur.

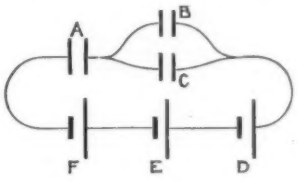
Thus we have a distinction of substances into those which are capable of forming continuously part of a galvanic circuit and those which are not; the former are called "conductors," the latter "non-conductors." The distinction will be found to be really one of degree.

Consider a wire forming part of the galvanic circuit: after a short time no change occurs in the wire; it is heated by the current, and it loses heat by heat conduction, convection or radiation. It is possible by the methods of calorimetry to measure the total quantity of energy leaving the wire as heat by these agencies; it must be equal to the quantity of energy brought into the wire by galvanic agency.

Again, consider the battery itself. A certain chemical reaction is going on; zinc is being oxidised, and other reactions are occurring. Of the net amount of energy liberated per second by these, some goes to heat the battery, but some also appears in parts of the circuit external to the battery—that is, leaves the battery by galvanic agency. Thus a galvanic current is an instrument which takes energy from certain parts of the circuit and takes it into other parts of the circuit; and when the current is steady the algebraic sum of the quantity of energy taken into all parts of the circuit is *nil*. Denote by E C the quantity of energy per unit of time taken into any section, A, B, of the galvanic circuit, the positive direction of the current being from A to B. If the whole of the circuit be broken into sections, the algebraic sum of the values of E C is *nil*, but the value of C is the same for all sections; hence the algebraic sum of the values of E is *nil*. Let there be any quantity, V_a, referred to each point of the circuit, such that $V_a - V_b = E$, the condition that the sums of the values of E shall be *nil* is fulfilled. E is therefore properly described as the difference of two quantities, one peculiar to A, the other to B; it is called the difference of potential between A and B, and V_a is called the potential at A, though it is only with differences of potential that we are concerned.

Suppose now the circuit divides at A into two or more branches, joining again at B, by our definition the difference of potential between A and B is the sum of the energies taken per unit of time into the conductors, A, B, divided by the sum of the currents in the conductors, A, B. We have now to show that the energy taken into each of the conductors, A, B, is equal to the difference of potential between A and B, multiplied by the current in that conductor. This is by no means obvious, but depends on an assumption of an experimental truth, viz., that in a given conductor the energy taken into it by the current is a function of the current only, and is independent of other conditions external to the conductor. Granted this, it easily follows that, if two or more conductors be joined at A and B, the potential difference between A and B deduced from each will be the same.

As we have defined difference of potential by means of work done in a conductor when a given current exists in it, the laws of resistance must have the same basis. In the case of a homogeneous metallic conductor under given constant physical conditions of temperature, stress, and magnetic field carrying a constant galvanic current, C, Joule found that the heat liberated per unit of time varies



as the square of $C = R C^2$, when R is a constant relative to C for the conductor. Whence follows that $E = R C R$ is called the electrical resistance of the conductor; for metallic conductors R is constant, but the constant, R, does not exist for all conductors; for the electric arc, for example, the heat generated varies more nearly as C than as C^2, and therefore E is more nearly constant than varying as C.

We have now gained two fundamental ideas—that of galvanic current, and difference of potential. In terms of what units are we to measure them? We have only one unit to choose, because E C must be expressed in terms of our mechanical unit of power. If a unit were to be fixed at this stage, it would be natural to define either a unit of current, or of resistance, the ratio of $\frac{E}{C}$; for example, we might say the unit of current shall be that current whereby a unit weight of distilled water is decomposed per second; or we might say, let the resistance of a piece of wire of defined shape and material, at a definite temperature, be the unit of resistance. The units in general use have an electro-magnetic basis; but be it observed that all rational systems must be such that E C is expressed in some ordinary mechanical units.

We have supposed that galvanic effects are measured by chemical change, and that the rate of galvanic effect—or, as it is generally called, the electric current—is measured by the rate of chemical change. From a theoretical point of view, it would be possible to thus measure electric currents; but for practical purposes other means are adopted—electrometers, galvanometers, electro-dynamometers, and the like. With a description of such instruments, and their methods of use, I have not the time to concern myself this evening. We must assume that we have the means of measuring C, the galvanic or electric current so called, at any instant, and E, the difference of potential, whether these be great or small, and with any desired accuracy.

We should now be in a position to give a detailed account of galvanic batteries and of electrolysis, and the theory of the distribution of currents in systems of conductors of any form, and we are in a position to place the theory of thermo-electricity upon a thermo-dynamic basis, without the introduction of any fresh idea. These, however, I leave on one side, and hasten to consider how the phenomena of electrostatics can be based upon what we have been discussing. There is a broad group of facts very familiar to the practical electrician engaged in laying telegraphic cables, of which I have as yet given no account: I refer to the phenomena of capacity. Let us examine a little more closely the statement that I made, that if a slip of paraffined paper were interposed between the two parts of a conductor, no electrical action would occur. Suppose that, instead of paraffined paper interposed between the ends of a wire, we have a very large number of sheets of tinfoil separated from each other by paraffined paper in such wise, that we have a great area of tinfoil connected together, and separated from another great area of tinfoil by nothing more than the paraffined paper. If, now, these two areas of tinfoil are suddenly connected to the poles of a galvanic battery, we find that it is by no means true that no galvanic effect will ensue; we find that a galvanic current exists, but that, whilst it begins with a large quantity, this quantity goes on diminishing, until, barring the slight imperfection of insulation of the paraffined paper, it becomes *nil*. We find, then, that it is not true to state that paraffined paper cannot form a part of a galvanic circuit; it can form a part of a galvanic circuit, but it does so under completely different laws to the metallic conductor. With the metallic conductor, the difference of potential at its two ends depends only on the current which then exists in that conductor, and not at all upon the currents which have previously existed; with paraffined paper, on the other hand, the difference of potential between the

sheets of tinfoil depends not at all upon the then current, but entirely upon the currents which have existed since its two coatings were connected together, and the times for which they have existed. A galvanic current may be measured by the rate of electrolysis; being measured by a rate, its time integral will have a perfectly definite meaning, and will be measured by the total quantity of substance which would be decomposed in a voltameter in the circuit. We find that the difference of potential between the two coatings of the paraffin condenser is proportional to the time integral of the current since the time at which the coatings were connected together last. The constant ratio of this time integral of current to the difference of potential is called the "capacity" of the condenser. Suppose, now, that the condenser has been connected to a galvanic battery, and the time integral of the current has been measured; let, now, the coatings of the condenser be disconnected from the battery and be connected together through any instrument for measuring the time integral of current; if this is accomplished with sufficient rapidity for loss by imperfect insulation to be negligible, we find that the time integral in the second case is equal and opposite to that which it was in the first. Here, again, is a difference from conduction in the ordinary sense. If a conductor in which a current has existed be disconnected from the source of current and be connected to any measuring instrument, no return current will be observed. Here, then, we have a new order of facts presented in an extreme case, but, in fact, applicable to all kinds of insulators. Suppose we diminish the area of surface of the paraffined paper, we diminish *pro rata* the capacity of the condenser; but even when the paraffined paper is merely interposed between the ends of two copper wires it still will be a condenser having a definite capacity. There is no need to use paraffined paper to form a condenser. Two metallic plates may be insulated and placed parallel to each other: if they be connected one to one pole of a battery, the other to the other, a current will exist for a finite time; if they are now disconnected from the battery and connected to each other through a suitable instrument for measuring the time integral of current, a return current exists for a finite time. Consider now a condenser consisting of two parallel plates of very large area placed near to each other: its capacity varies as the area of the plates, and it also varies inversely as the distance between them—laws precisely analogous to those of conductors. It also, as might be expected, depends upon the material interposed between the two plates. Since the capacity of the condenser varies as the area, and inversely as the distance, whatever be the substance between the plates, there is a constant for every substance analogous to the specific conductivity of the material; this constant is called the "specific inductive capacity" of the material.

That the magnetic effects of the transient galvanic currents in insulators are the same as of corresponding currents in conductors, is a fundamental law at the basis of Maxwell's theory of electromagnetism; it was, I believe, first definitely propounded by Maxwell, and it is one over which some of the most eminent minds have since contended. You will notice how, if the subject be arranged in the unhistorical, but not unnatural, way I have adopted this evening, this law drops so easily into its place, that its assumption would be almost unnoticed. Why should we assume that the magnetic effects of electric currents in insulators and in conductors are different? By far the most natural assumption is that they are the same.

Maxwell's electro-magnetic theory of light—one of the great generalisations of the century—is directly based upon this law. What is this theory? It is simple enough in its character, broadly stated. Suppose you have an electrical disturbance, a transient galvanic current, in any dielectric, this disturbance—assuming the magnetic effects of currents in dielectrics to be the same as in conductors—will be propagated as a wave in directions perpendicular to the direction of the currents. The velocity of the wave can be calculated from purely electrical experimental knowledge; it is 3×10^{10}, if the dielectric be a vacuum. The velocity of light is 3×10^{10}. We know nothing of what light is; we do know that it is a wave, and that the disturbance is perpendicular to the direction of the transmission of the light; but what is the ultimate nature of that disturbance we have no idea from the standpoint of the science of light. Is it not infinitely probable that the waves of light are none other than the electrical waves which we know must exist, and must be propagated with the observed velocity of light? And, mark, this theory demands no ether; it merely identifies the phenomenon of light with known phenomena of electricity and magnetism; it demands no knowledge of the fundamental nature of these phenomena, it demands only a knowledge of their laws. Surely Maxwell's generalisation is similar both in kind and in magnitude with the discovery of universal gravitation. Newton showed that the force which caused any body—an apple, if you like—to fall on our earth was the same as the force which kept the planets in their courses. He gave no theory of how that force was transmitted, nor of what, in its inmost nature, it was. He merely identified the two forces as one. So now Maxwell's theory may be shorn of all reference to an ether; it identifies as one the forces whereby light is transmitted and the forces with which we are familiar in our dynamo machines, and shows that they are measurably the same. It does not pretend to say what electricity and magnetism are, or what, if any, is the medium whereby the disturbances on which both depend are transmitted. Whether the postulate of an all-pervading ether be, or be not, a metaphysical necessity, surely it is well for the practical man and the physicist to leave the question to the metaphysician. My point, however, is that the hypothesis of two electric fluids and the ethereal theory of light have rather delayed than accelerated the acceptance of a great generalisation. Let us now return to elementary matters.

I have just stated that the capacity of two large plates near and parallel to each other varies as their area, and inversely as their distance. In what units are we to measure capacity? If we have already chosen a unit of resistance, a unit of capacity must follow from that through the units of potential and current. It would be the capacity of that condenser which, if brought to unit difference of potential, would discharge a galvanic current whose time integral was unit current for unit time. It would be quite natural to define as a unit of resistance the resistance between opposite faces of a cube of a defined substance at a defined temperature, in which case the dimensions of resistance would be the reciprocal of a length. Or, again, we might lay by a piece of wire and carefully preserve it, and say, let that be our unit of resistance. Then resistance would have no dimensions in terms of mass, length, and time—it would be a fundamental unit. In either case we should introduce physical constants into our formulæ for electrostatic and electro-magnetic phenomena, depending in the one case on the physical properties of the substance chosen, in the other on its actual dimensions. If the history of electrical discovery had followed the course adopted in this discourse, and it had become necessary to fix upon a unit of capacity at the point we have now reached, it would have been very natural to have taken the capacity per square centimetre of two plates at unit distance, the insulating medium being vacuum. We shall see shortly what is the actual electrostatic unit which has been chosen, but the fact is there is nothing specially natural, nothing specially absolute in the choice.

It is a matter of very great interest to know the capacities of condensers of various forms. Let us take, for example, the case of a sphere enclosed concentrically within another sphere. If r_1, r_2, be the radii of the two spheres, the result is that the capacity varies as $\frac{r_1 r_2}{r_2 - r_1}$; if r_2 be very great in comparison with r_1, the capacity varies as r_1. The electrostatic unit of capacity ordinarily adopted as absolute is the capacity of a sphere of unit radius enclosed concentrically in a very great sphere, with vacuum as insulator. From this, remembering that the product of a difference of potential and a galvanic current shall be power in ordinary mechanical units, all other units will follow. Thus time integral of current divided by difference of potential or capacity is a line; therefore conductivity is a velocity, and resistance the reciprocal of a velocity. Difference of potential multiplied by current is power, and has dimensions $\mathrm{M\,L^2/T^3}$, but potential divided by current has dimensions $\mathrm{T/L}$; therefore current squared has dimensions $\mathrm{M\,L^3/T^4}$, and current $\mathrm{M^{\frac{1}{2}}\,L^{\frac{3}{2}}/T^2}$, and so on.

Again, the capacity of two plates, area A, distance x, can be deduced from that of two concentric spheres at a small distance apart: it is $\mathrm{A}/4\,\pi\,x$ in these units.

We may now prove that mechanical forces must exist between the plates of a charged condenser. Let a condenser be formed of two parallel plates of area, A, at a distance, x, from each other, the distance, x, being capable of variation; let the condenser be charged to a given difference of potential, and then insulated, and the position of the plates in relation to each other varied. If the condenser be then discharged, it is found, first of all, that the total discharge is the same however the position of the plates be varied. Suppose now that the condenser be charged to a difference of potential, E, and a quantity, or time integral, of current, Q, the work done in so charging the condenser will be $\frac{1}{2}\,\mathrm{E\,Q}$. Let now the condenser be insulated, and the distance of the plates increased to $x + \delta x$: the capacity of the condenser will be diminished in the ratio $x/(x + \delta x)$; and therefore, since the quantity remains the same, the difference of potential will have increased to $\mathrm{E}\,(x + \delta x)/x$. Now discharge the condenser. The work done by the discharge will be $\frac{1}{2}\,\mathrm{E\,Q}\,(x + \delta x)/x$, or an amount of work $\frac{1}{2}\,\mathrm{E\,Q}\,\delta x/x$ greater than was done in charging the condenser. This work must come from somewhere. The only way in which it can be introduced is by the work done in separating the plates from each other. To increase the distance between the two plates by an amount, δx, therefore requires that we shall do mechanical work, $\frac{1}{2}\,\mathrm{E\,Q}\,\delta x/x$, upon the plates. This mechanical work is done through a distance, δx, therefore a force must be exerted in separating equal to $\frac{1}{2}\,\mathrm{E\,Q}/x$; hence it follows, as a matter of necessary consequence from the laws of the capacity of conducting surfaces in the presence of each other, that those surfaces shall, when charged, act mechanically upon each other; and the amount of mechanical force is determined.

Now $\mathrm{E} \cdot \frac{\mathrm{A}}{4\,\pi\,x}$ is equal to Q, hence the force between the plates is $\frac{2\,\pi\,\mathrm{Q}^2}{\mathrm{A}}$. Let us now suppose that matter is laid upon each plate of density $\frac{\mathrm{Q}}{\mathrm{A}}$, and that the matter on one plate attracts that on the other plate with a force varying as the inverse square of the distance: the resultant attractive force between the plates is exactly $\frac{2\,\pi\,\mathrm{Q}^2}{\mathrm{A}}$; hence we should accurately express the facts of attraction of two plates if we said there is on each plate a charge of electric substance, and every particle of substance on the one plate attracts every particle on the other with a force varying inversely as the square of the distance. But that the facts can be so expressed, is no evidence that any such electric substance exists.

I do not propose to touch on electro-magnetic and magnetic phenomena; I would only point out this: Just as electrostatics has been based on action at a distance between hypothetical electrical fluids, so magnetism has been based on the action at a distance of hypothetical magnetic fluids. There can be no doubt that the science could be easily rearranged, and that the phenomena of electromagnetism could be made fundamental, and that the facts concerning permanent magnets could be made subsidiary thereto, exactly as we have deduced this evening the facts of electric attraction from the phenomena of current electricity. I believe that in the future this is the way the science must be arranged for practical men. They are but little concerned with the attractions between charged spheres and the like, and very much concerned with the laws of currents and differences of potential and capacities. The theory of permanent magnets has for the modern electrical engineer only

a general interest, but the laws of magnetic circuits and induction therein are all-important. It would seem that the subject needs rearranging, and that that which is most important should be put most prominently forward. I even venture to think that this would be no loss to pure science; we should see with increased clearness how little we know what electrical phenomena really are, and how much we know of how electrical laws work. We should see how much there is that is arbitrary and conventional, and by no means absolute, in the system of units we have adopted. The science of electricity is so essential to the practical electrical engineer that it should be arranged so that he can learn in logical order what he most wants to know. In what I have briefly indicated there will be something which is trite to all, and something, perhaps, not easy to comprehend when stated too shortly. My aim has been rather to excite in your minds discontent with the way in which the science of electricity is usually arranged, in the hope that such discontent may take an articulate form, and become a demand for something more convenient for your particular purpose. When the demand becomes clear it will not be long before it is supplied.

I am informed by Prof. S. P. Thompson that he has for some time past in his lectures begun the subject of electricity with the consideration of currents. My attention has also been called to Prof. Ayrton's excellent book on "Practical Electricity," with the contents of which I ought to have been, but was not, acquainted, in which a similar arrangement of the subject was adopted no less than nine years ago.—J.H.
January 22nd.

Dr. S. P. THOMPSON moved: "That the thanks of this meeting are due to the president for the interesting address just delivered by him, and that he be requested to permit its publication in the *Proceedings* of this Institution." He, personally, could not thank the president too heartily for the stimulus which he had given them to modernise the science which that Institution was to promote, and he (the president) was to preside over during the coming 12 months. He had long felt that they were too much bound by the methods, ideas and language of those who had preceded them, and if they could manage to dispense with the antiquated law of the last century, and adopt the president's suggestion of living in their own century, he was sure that not only would they be gainers, but the science itself would profit. He had nothing to regret in the president's new view, which was not altogether new to some of them. He had only hoped the president might have gone further and dropped electrostatics altogether, and even the galvanic cell, and based himself on the dynamo rather than upon the antiquated galvanic cell. But that was by way of criticism, and he would say no more. They wished to thank him heartily, and recognised that he was among those who deemed it an honour to teach.

Prof. A. B. W. KENNEDY seconded the motion. There was a very large number of members of that Institution who had, unfortunately, passed a certain age, and when they had passed a certain age it followed, as a matter of course, that they had learned the electricity of the century before last; and when they had to try and learn another electricity, they found between the two a great gulf fixed, and for some of them that gulf was only just beginning to be bridged over. He thought if the president had helped forward from the academic side the education of the coming engineers in such a manner that that gulf should no longer for them have any existence, he would in that alone have added in no small measure to the many matters for which they are all so much indebted to him.

The PRESIDENT having suitably acknowledged the vote of thanks, the meeting terminated.

The Société des Electriciens.

MEETING OF JANUARY 8TH, 1896.

M. D'ARSONVAL took the chair in the absence of M. Potier, who was ill. The report of the last meeting was read and adopted. The secretary then read out a list of works submitted to the society and of new members admitted.

M. FAYOT then read the results of some trials of De Laval's turbine with regard to its consumption. A turbine of 50 H.P. at a pressure of 5 kg. consumed 10·58 kg. of steam per H.P. hour. At Bordeaux, a turbine of 100 H.P. working with full load for seven hours consumed 9·160 kg. of steam per H.P. hour; the same turbine at 50 H.P. consumed 10·8 kg. of steam per H.P. hour. At Vienna, after a service of nine months, this consumption amounted to 8·9 kg. after 10 hours' trial. At Troyes, a turbine of 200 H.P. worked a transmission plant driving four dynamos at a pressure of 5 kg., the consumption of steam was 8·9 kg. per H.P. hour. At the shops in the Place Clichy, Paris, a turbine of 75 H.P. at full load consumed 10·5 kg. of steam per H.P. hour at a pressure of 12 kg. M. Fayot then explained various curves showing the variation of consumption with the power, the number of pipes, &c.

M. HILLAIRET wished to know what was the turning moment at starting, and M. FAYOT explained that this moment is greater by 30 to 35 per cent. than the normal moment.

M. ARNOUX then said that it is possible to show why the rendering is higher in high-power turbines. This increase is due to the higher speed of the float boards; in turbines of 200 H.P. they could attain a speed of 400 metres per second, and in turbines of 75 H.P. a speed of 60 metres per second.

M. HOSPITALIER, vice-president, then took the chair, and Dr. d'Arsonval held a conference on the Blot accumulators. These accumulators, which are of the pure Planté type, can work for a certain time on short circuit. Two examples at the meeting gave out 100 amperes. Tests, strictly and carefully carried out, were made from February, 1895, to January, 1896, by Mr. Preece in London, and by M. d'Arsonval in Paris. The results were as follows:—One element of 20 kg. was put on short circuit for 10 minutes, and gave 200 amperes; it was then recharged, and discharged at 1 ampere per kg. The efficiency in capacity was 79·2 per cent., and the efficiency in energy 64 per cent. The plates were in perfect condition. Other similar trials gave efficiencies in capacity of 84 per cent., and in energy of 68 per cent. After some time capacities of 10 and 12 amperes per kg. were reached. These accumulators can remain charged for a long time without losing any of their charge. M. d'Arsonval had a battery that remained charged for four months. He stated that these accumulators were of great service to him at his laboratory at Concarneaux, on the sea-coast. A windmill works a dynamo, which charges the accumulators. According to the wind the rate of charge may be either very low or excessive. The Blot accumulators accommodated these extremes perfectly.

Lieutenant DARRIEUX then asked for the efficiencies at various rates. M. d'Arsonval gave him the following figures for the efficiencies in quantity:—

At the rate of	1 ampere per kg.	... ...	89 per cent.
"	2 "	... ...	75 "
"	3 "	... ...	68 "
"	5 "	... ...	50 "
"	5·6 "	... ...	45 "

One of the audience said that he had obtained with the Fulmen accumulators capacities of 18 and 15 ampere-hours per kg. at rates of 1 and 5 amperes per kg. on an electrical carriage.

M. HOSPITALIER then read an interesting paper on lighting with acetylene gas. The mode of producing this gas from the carburet of calcium is old; he quoted the researches of M. Wobler in 1862, Borcher in 1888 and 1891, and the recent experiments of Messrs. Wilson, Bullier, Chapelet, Vincent, and Moissan. At the present day, carburet of calcium can be produced industrially by tons. We may reckon that 1 kg. of carburet gives practically 280 litres of acetylene gas. The carburet costs at present 400 francs per ton at Neuhausen, and about 600 at Paris. Acetylene gas has a strong smell; it weighs 1,169 grains per cubic metre, its heat of combustion is 8,301 calories per kg., it attacks copper, but does not affect brass, bronze, iron, and tin. Acetylene will cost about 11·50 francs the cubic metre in Paris (from 4 to 5 kg. of carburet of calcium being required), or five times more than ordinary gas. This gas might be used for many purposes besides lighting; chemists could employ it for the preparation of benzine and alcohol, for welding iron, and for obtaining high temperatures. With an equal volume, acetylene gives 15 times as much light as ordinary gas. M. Hospitalier demonstrated this by lighting successively acetylene gas burners and the ordinary Bengel, Manchester, and butterfly gas burners. He then summed up in the following table the cost of the carcel-hour in centimes, and the quantity of heat given off in calories per hour.

		Price of the carcel-hour in centimes.	Heat given off in calories per hour.
Stearine candle		20	...
Petroleum lamp		2·7	300
Gas burners.	Candle	6	3,040
	Butterfly	3·6	660
	Bengel	3	520
	Auer	·6	100
Incandescence lamp		3	26
Acetylene gas burner		3	74

The acetylene, however, can give very low intensities. M. Hospitalier lighted a burner consuming 4 litres per hour. The Auer burner cannot go lower than 4 carcels. M. Hospitalier then said a few words about portable apparatus for this gas. He thought that in order to utilise this gas it would be necessary to instal the requisite apparatus at the house. It cannot be conveyed in mains for fear of explosions. The enriching of the ordinary gas is very difficult. Railway companies will be able to use acetylene for lighting their carriages. The central stations of electrical energy will find that the production of carburet of calcium will form an important item in the daily consumption of electrical energy.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Compiled expressly for this journal by* W. P. THOMPSON & Co., *Electrical Patent Agents*, 31, *High Holborn, London, W.C., to whom all inquiries should be addressed. Copies of any of the specifications may be obtained of* Messrs. W. P. THOMPSON & Co., *price, post free,* 8½*d. (in stamps.)*]

NEW PATENTS.—1896.

342. "A new or improved combined portable electric light and current generating apparatus." J. R. WELLAND. Dated January 6th.

347. "An improved switch for electrical purposes." C. B. WOOD. Dated January 6th.

355. "An electrical regulator for regulating arc lamps and for other purposes." A. L. Davis. Dated January 6th.

366. "An electrical attachment as applied to valves, taps, and cocks or the like acting as a safety and 'detector' in the delivery of fluids or gases." J. C. Berry. Dated January 6th.

390. "Improvements in electrical switches." J. T. Leroux. Dated January 7th.

434. "New and useful phase completing device." T. McKenna. (Electric Selector and Signal Company, United States.) Dated January 7th.

452. "Improvements in apparatus for controlling electric motors." H. H. Lake. (B. A. Fiske, United States.) Dated January 7th.

473. "An improved friction clutch for electrically or mechanically propelled vehicles." W. C. Bersey. Dated January 7th.

474. "An improved turning plate for electrically or mechanically propelled vehicles." W. C. Bersey. Dated January 7th.

475. "Improvements in electric accumulators." W. C. Bersey. Dated January 7th.

477. "Improvements in electrical storage accumulators." C. N. Stewart. Dated January 7th.

533. "Improved automatic remontoir apparatus for Hughes' telegraph apparatus." Siemens Bros. & Co., Ltd. (Siemens & Halske, Germany.) Dated January 8th.

535. "Improvements in primary and secondary batteries." H. W. Headland. Dated January 8th.

543. "Improvements in or relating to means for producing differences of phase in alternating current apparatus, specially applicable to meters, motors, and the like." G. Hummel. Dated January 8th.

546. "Improvements relating to electric incandescence lamps, and to adapter fittings therefor." R. T. Bott. Dated January 8th.

547. "Improvements in devices for joining or connecting electrical cables or conductors." H. Edmunds. Dated January 8th.

551. "Improvements in dynamo-electric machines and motors." L. B Atkinson. Dated January 8th.

557. "Improvements in electric batteries." R. Collins and F. Cogan. Dated January 8th.

565. "Improvements in apparatus for transforming continuous electric currents." H. H. Lake. (Cie de l'Iadustrie Electrique, Switzerland.) Dated January 8th.

604. "Improvements in insulated anchoring apparatus for use on underground or overhead conductors of electricity." S. W. Baynes. Dated January 9th.

699. "Improvements in electric arc lamps." H. N. Moody. Dated January 10th.

701. "Improvements in electric signalling apparatus." B. Marinovitch. Dated January 10th.

710. "Improvements in and relating to electric accumulators." A. C. Miles and B. F. De Morgenstern. Dated January 10th.

711. "Improvements in and relating to arc lamps." A. C. Miles and B. F. De Morgenstern. Dated January 10th.

712. "Improvements in and relating to electric motors." A. C. Miles and B. F. De Morgenstern Dated January 10th.

719. "Improvements in electrical accumulators or storage batteries." B. Willcox. (La Societe L'Accumulateur Fulmen, France.) Dated January 10th.

722. "Improvements in electric arc lamps." J. I. Thornycroft and J. E. Thornycroft. Dated January 10th.

736. "Improvements in electric tramways or railways." W. B. Edgar. Dated January 11th.

741. "Novel or improved means for excluding dust or the like from incandescent lamps." G. M. Archibald. Dated January 11th.

778. "Improvements in secondary batteries." H. W. Headland. Dated January 11th.

780. "A new or improved method of manufacturing electrodes for secondary electric batteries." H. Leitner. Dated January 11th.

791. "Improvements in primary voltaic batteries." W. Walker, Jun., F. R. Wilkins, J. Lones, and C. Vernon. Dated January 11th.

793. "A new or improved electrical lamp." H. J. Dowsing and H. S. Keating. Dated January 11th.

794. "A new or improved electrical lamp." H. J. Dowsing and H. S. Keating. Dated January 11th.

810. "Improvements in apparatus for automatically controlling the supply of electricity and gas, water, or other fluids." G. C. Fricker. Dated January 11th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

1895.

825. "Improvements in arc electric lamps." J. J. Mann and L. Hermand. Dated January 12th. Relates to an arc lamp having tubular carbon carriers, the carbons being pressed forward as they are consumed, by springs against a retaining claw at the end of the tube. The mechanism for striking the arc consists of two solenoids, one of thick and the other of thin wire, operating on a core to which one carbon carrier is connected. 6 claims.

1,676. "Improvements in electrical storage batteries." J. B. Marchant and J. Woolley. Dated January 24th. In place of the usual leaden plates ordinary commercial lead shot is used. The shot may be hollow or indented if desired. Before using, the shot is subjected to a forming process. 4 claims.

1,899. "Improvements in connection with the conduits for electric railways or tramways." E. Mapple. Dated January 26th. The troughs or channels are connected to arms hinged to brackets formed on the exterior of chairs arranged at suitable distances along the track. The chairs are of ∪ section and are provided with feet. The troughs or channels rest on brackets on the interior of these chairs. The arms are held by keys or cotters so that when the key is removed the trough or channel may be lifted. 5 claims.

1,940. "An improvement in electrical controlling switches." E. Hopkinson and A. P. Wood. Dated January 28th. Relates to an electric controlling switch of which the contact arm, the pin on which it turns, and the plate carrying the contacts are made of steel and form a magnetic circuit which is excited by the current passing through a coil surrounding the central pin, producing a powerful magnetic field at the contacts tending to blow out any arc formed there. 3 claims.

14,158. "Improvements in and relating to primary batteries." W. Rowbotham. Dated July 25th. This is an improvement on the invention described in specification No. 13,730 of 1895. Instead of the lower ends of tubes opening into a carbon chamber, they are conducted out of the bottom of the cell, so that both ends are open to the atmosphere. 2 claims.

14,638. "Improvements in electric brakes." J. C. Chapman (W. B. Potter). Dated August 1st. On the rupture of a train coupling, a circuit is completed through the brake magnets on that portion of the train separated from the motors. Current for this circuit supplied by small generators carried by each car on its axles. The engineer is notified of any break in the train by a shunt from the trolley circuit to earth, which is arranged to sound a gong. 9 claims.

15,371. "Improvements in and connected with primary batteries." W. Rowbotham. Dated August 15th. Instead of making the carbon element of tubes, as in specifications Nos. 13,730 and 14,158 of 1895, it is made of a plate of carbon having holes therethrough and open to the atmosphere at both ends. 4 claims.

17,269. "Improvements in galvanic dry cells." C. E. C. Jangnickel. Dated September 16th. To obviate the bursting of dry cells hollow regulators or cylinders are provided, with a small aperture communicating with the inside of the cell, which act as a vent into which the gases generated in the cell by heat, may escape. 2 claims.

17,290. "An adjustable support for electric lamps or similar fixtures." O. C. White. Dated September 17th. Relates to a stiff support for electric lamps, similar to a gas bracket, and consists of two tubes jointed by an adjustable joint in the middle, and having a universal joint at the ceiling or wall. The lamp being connected by an ordinary elbow joint. Where the wires enter the tubes the ends are preferably bushed with insulating material. 9 claims.

18,105. "An improved automatic fire alarm." G. A. Lyncker and A. Schropp. Dated September 27th. The two wires of a bell or other alarm circuit are inserted down one side of an elbow tube, the other side being sealed up. In the elbow is a small quantity of quicksilver. On the air in the sealed side becoming heated it expands and drives the mercury against the wires, completing the circuit. 1 claim.

19,317. "Improvements in the conduit system of electric railways." J. L. Burt. Dated October 15th. Relates to a means for energising the conductor as the car proceeds. By an arrangement of rock levers and contact plates, the contact line is energised from the main conductor as the car proceeds, and de-energised on the passing of the trolley by the insulated sections, into which the contact line is divided, falling by gravity, thus breaking the contact of the parts. 7 claims.

19,696. "Improvements in electric light display systems for use as signs or for advertising or for similar purposes." J. E. Woodbridge. Dated July 8th. Each lamp on the signboard is connected to the main line wire, and an electro-magnetic switch and each switch is connected to the other main line wire, and a hand switch is placed in one main line wire. As the armature of each magnetic switch is operated a lamp is lighted. A number of metal discs mounted on an insulated back are each connected to a magnetic switch, so that as a metal pencil connected to one main line is drawn across them the lamps are lit. 5 claims.

19,861. "Improvements in three-wire electric railways." J. Devonshire. (W. B. Potter.) Dated October 22nd. In present methods where the earth or rail return forms the neutral of the system, the very large carrying capacity of the track is wasted. In this invention a track return at zero potential is employed, a positive at 1,000 volts and a neutral intermediate conductor at 500 volts above the track and below positive conductor. By this means the smallest possible conductor may be used for the neutral. 3 claims.

19,863. "Improvements in regulators for alternating currents." J. Devonshire. (C. P. Steinmetz.) Dated October 22nd. This invention relates to a regulator for an alternating current system of distribution comprising a plurality of coils in inductive relation, part in series in the main circuit part in shunt thereto, a magnetic structure surrounding the coils and a movable magnetic member enclosed by the coils and adapted to vary the path of the lines of force, and thus the inductive effects of the coils; the movable magnetic member is composed of laminated iron occupying a part of the opening between the coils and a non-magnetic shield attached to and moving with the iron occupying the remainder of the opening. 6 claims.